5-A-41

INSTRUCTION MANUAL

MODEL 133

LF TRIGGER GENERATOR

WAVETEK

Product Improvement Notice

Wavetek maintains a continuing program to make improvements to their instruments that will take advantage of the latest electronic developments in circuitry and components.

Due to the time required to document and print instruction manuals, it is not always possible to incorporate these changes in the manual.

Wavetek has manufactured your instrument, using metal film 1% tolerance resistors in place of 5% carbon resistors, wherever practical. This results in a substantial improvement in the overall performance of your instrument. Therefore, there may exist a discrepancy between the resistor used to manufacture your instrument and the resistor called out in the Parts List and Schematic Diagrams in this manual.

If field replacement of an affected resistor does become necessary, replacement may be made in accordance with the manual call outs. Wavetek, however, recommends replacement with the same type of resistor used in the manufacture of your instrument, whenever possible.

WARRANTY

All Wavetek instruments are warranteed against defects in material and workmanship for a period of one year after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective, under normal use, during this period. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which in Wavetek's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

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SCOPE OF MANUAL

This manual contains instructions for operating, testing, and maintaining the Wavetek Model 133 Low Frequency Trigger Generator. The Wavetek product improvement program ensures that the latest electronic developments are incorporated into the Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print these Instruction Manuals, it is not always possible to get these changes incorporated into the manual. In this case, data will be found on addendum change page(s) at the back of the manual. If there are no change sheets, the manual is correct as printed.

SCOPE OF EQUIPMENT

The Model 133 is a precision source of sine, triangle, and square waveforms, with selectable and variable amplitude outputs useable over a frequency range of 0.000002 Hz to 200 kHz. It is ideal for ultra low and mid-range frequency operation. The signal may be triggered and gated manually or externally, and the start/stop point of the triggered waveform is adjustable through approximately $\pm 90^{\circ}$.

SECTION 1
SPECIFICATIONS

VERSATILITY

Waveforms

Sine ∿ , square ⊓ , and triangle ∿

Dynamic Frequency Range

0.000002 Hz (or 2μHz) to 200 kHz
Calibrated range — 100 μHz to 200 kHz

Ranges

X 0.001*	0.00002 Hz to 0.002 Hz
X 0.01*	0.0002 Hz to 0.02 Hz
X 0.1*	0.002 Hz to 0.2 Hz
X 1*	0.02 Hz to 2 Hz
X 10	0.2 Hz to 20 Hz
X 100	2 Hz to 200 Hz
X 1K	20 Hz to 2 kHz
X 10K	200 Hz to 20 kHz
X 100K	2 kHz to 200 kHz

*Denotes auxiliary multiplier ranges for ultra low frequency operation.

Outputs

Sine ∿ , square ⊓ , and triangle ∿ selectable; output is controlled with 60 dB step attenuator in 10 dB steps and overlapping vernier control; 50Ω output impedance (600Ω available); 20 V p-p into open circuit and 10 V p-p into 50Ω load from 50Ω source impedance; short circuit current is ±100 milliamperes.

Sync Output

Greater than 1 V p-p square wave into open circuit at 600Ω output impedance. Output located on rear panel.

DC Offset

±5 V offset (±2.5 V offset into 50Ω load) controlled from front panel; peak amplitude limited by the dynamic range of the amplifier output. DC offset and output waveform attenuated proportionately by the 60 dB output attenuator.

Trigger

External trigger input is located on the rear panel and input impedance is 10 kΩ. Manual trigger is also provided.

Manual switch or external voltage of +1 V minimum peak will generate one cycle of a selected waveform.

Up to 100 volts may be applied without damage to the input circuitry. The external trigger level and the waveform start/stop point are adjustable by front panel controls.

VCG — Voltage Controlled Generator

Frequency of the generator may be dc-programmed or ac-modulated by external 0 to 5 V signal. Voltage control circuitry is capable of 1000:1 deviation. The VCG amplifier has a 100 kHz bandwidth and a slew rate of 0.1 V/μs. The instantaneous frequency is the result of the sum of the dial setting and the externally applied voltage.

HORIZONTAL PRECISION

Dial Accuracy

±2% of full scale on X 1 through X 100K ranges ±(2% of setting +2% of full scale) on X 0.001, X 0.01, and X 0.1 ranges

Electronic Frequency Vernier

One turn for approximately 1% of full-scale change

Time Symmetry

±1%	X 1 to X 100K range
±3%	X 0.001 to X 0.1 range

VERTICAL PRECISION

Sine Wave Frequency Response

Amplitude change with frequency less than:
0.1 dB from 0.00002 Hz to 20 kHz
0.2 dB to 200 kHz

Step Attenuator Accuracy

±0.25 dB/10 dB

Stability

Short term	±0.05% for 10 minutes
Long term	±0.25% for 24 hours

Percentages apply to amplitude, frequency and dc offset.

Start/Stop Point Variation
Base line voltage varies less than ±0.1% of step attenuator range maximum as frequency is varied from 0.2 to 2 on the dial.

PURITY

Sine Wave Distortion
Less than:

3% on X 0.001, X 0.01, X 0.1 ranges
0.5% on X 1, X 10, X 100, X 1K, X 10K ranges
1% on X 100K range

Square Wave Rise and Fall Time
Less than 50 ns

OPERATIONAL MODES

CONT — Continuous — Operates as a standard VCG. Frequency determined by dial, vernier, and range settings in parallel with VCG input.

TRIG — Triggered — One complete cycle is generated by applying a pulse to the trigger input, or by operating manual switch.

GATED — Same as triggered mode, except that cycles continue for the duration of the input gate, or as long as the manual trigger switch is held closed. The generator is not running when the trigger pulse is absent.

NOTE

Manual trigger switch is operational whenever the instrument is set to either TRIG or GATED MODE.

ENVIRONMENTAL

Temperature
All specifications listed, except stability, are for 25°C ±5°C. For operation from 0°C to 55°C, derate all specifications by a factor of 2.

MECHANICAL

Dimensions
8½" wide, 5¼" high, 11½" deep

Weight
8 lb net, 11 lb shipping

Power
105 V to 125 V or 200 V to 250 V, 50 Hz to 400 Hz. Less than 20 watts.

NOTE

Unless otherwise specified, all specifications apply for frequencies obtained when dial is between 0.1 and 2 and at 10 V p-p into a 50 ohm load.

It is possible to stop the generator from oscillating by applying a negative voltage to VCG IN when the dial is already set at minimum frequency. Inputs up to 30 V will not permanently damage the instrument, however.

SECTION 2
OPERATION

INSPECTION

The following procedures should be performed to assure the user that the instrument has arrived at its destination in satisfactory operating condition. Complete calibration and checkout instructions are provided in Section 4 to determine compliance with electrical specifications.

Checking Visually

After carefully unpacking the instrument, visually inspect the external parts for damage to knobs, dials, indicators, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in case reshipment is required.

Checking Electrically

NOTE

Instruments are normally shipped connected for 115 V power unless 230 V power is ordered. Refer to the end of this section for conversion instructions.

The steps in this paragraph provide a quick checkout of the instrument operation. If electrical deficiencies exist, refer to the WARRANTY in the front of this manual. The following test equipment is recommended for performing this electrical inspection:

Instrument	Required Characteristics
Oscilloscope	To 30 MHz
Counter-Timer	To 2 MHz with 5-digit resolution

1. Turn FREQ HZ selector to the X 1K position. (This connects ac power to the unit and establishes the frequency multiplier.)
2. Connect the 50Ω OUT connector to the oscilloscope with a 50Ω terminator. Connect the SYNC OUT connector (rear panel of generator) to the external trigger of the oscilloscope.
3. Set frequency dial to the 1.0 mark and frequency VERNIER to CAL position.
4. Set MODE selector to CONT position.
5. Set function selector to ∿ position.
6. Set OUTPUT ATTEN (dB) selector to 0 position and rotate OUTPUT VERNIER (dB) control to maximum cw position.
7. Set FREQ MULT selector (ranges indicated in red) to X 1 position.

NOTE

When using FREQ HZ selector ranges, FREQ MULT selector should always be in the X 1 position. Failure to do this may cause undesirable output noise.

8. Check to assure DC OFFSET is pushed all of the way in. This automatically provides centering at ground.
9. Turn TRIG LEVEL control fully ccw.
10. Set START/STOP POINT control to midpoint.
11. Check oscilloscope display for 1 kHz sine wave with greater than 10 V p-p amplitude.
12. Select ∿ and ⊓ positions with function selector and check to assure each displays a 10 V p-p amplitude.
13. Step OUTPUT ATTEN (dB) selector through the ranges verifying change of signal attenuation at each position. Return OUTPUT ATTEN (dB) selector to 0 position.
14. Rotate OUTPUT VERNIER (dB) control from maximum cw to maximum ccw position and check to assure signal amplitude decreases. Return OUTPUT VERNIER (dB) control to 0 position.
15. Turn frequency dial from maximum ccw to maximum cw position with frequency VERNIER in the maximum cw position. Check for approximately 100:1 frequency change. Turn frequency VERNIER to maximum ccw position. Check for approximately 10:1 additional frequency change.

NOTE

With the frequency dial in the extreme cw position (the bottom of the dial), and the frequency VERNIER turned fully ccw, the generator may stop oscillating. This is well below 1/1000th of maximum frequency of the range. This condition is easily corrected by turning the frequency VERNIER control in a cw direction until oscillation again occurs. It is also possible to stop the generator from oscillating when the frequency dial is in the extreme cw position and a negative voltage is applied to the VCG input. This condition can easily be corrected by applying a positive voltage to the VCG input, thereby starting oscillation.

16. Rotate frequency VERNIER to extreme cw position.
17. Connect 0 to +5 Vdc to the VCG IN connector. Slowly increase voltage input from 0 to maximum, while checking to assure approximately 100:1 frequency change occurs.
18. Set function selector to ∿ position. Set MODE selector to TRIG position. Disconnect power source from VCG IN connector. Push MAN TRIG switch down and release several times while observing oscilloscope display. A single output waveform should be displayed each time the MAN TRIG switch is pushed down.
19. Set MODE selector to GATED position. Push MAN TRIG switch down while observing oscilloscope display. A continuous series of output waveforms should be displayed until the MAN TRIG switch is released.
20. With generator in the GATED MODE (no output waveform), pull the DC OFFSET control out and rotate in both directions. Base line should vary from +2.5 V to −2.5 V. Push DC OFFSET control in. Base line should return to 0 V. Set MODE selector to CONT position.
21. Set function selector to ⊓ position. Set frequency VERNIER to CAL position; frequency dial to 2.0; FREQ HZ selector to FREQ MULT position; and FREQ MULT selector to X 0.01 position. Use the counter to measure a cycle period of approximately 50 seconds.
22. Set function selector to ∿ position. Set FREQ HZ selector to X 1K position. Connect a trigger source to the TRIG IN connector on the rear panel and to the oscilloscope external trigger input. Set trigger source to provide a 1 kHz sine wave of 2 to 5 V p-p. Set MODE selector to TRIG position. Adjust TRIG LEVEL control to provide a triangle output from the generator. Verify that the TRIG LEVEL control will move the trigger point along the sine wave input. Verify that rotation of the START/STOP POINT control will vary the point at which the triangle wave begins from approximately the negative peak to the positive peak.

OPERATING CONTROLS

The operating controls and electrical connections for the Model 133 are shown in Figures 2-1 and 2-2. Each of the following paragraph numbers corresponds to a number appearing in Figure 2-1, front panel, or Figure 2-2, rear panel. The listing below discusses each control and its function.

Front Panel

1. **FREQ HZ/PWR OFF** — Selects one of five decade ranges from X 10 to X 100K for generator frequency. This value multiplied by the frequency dial setting (3) gives the output frequency of the generator. When set to the FREQ MULT (red letters) position, the FREQ MULT (14) selector value multiplied by the frequency dial setting (3) gives the output frequency of the generator. Extreme ccw rotation will place the FREQ HZ switch in the PWR OFF position, turning off all power to the generator.

2. **Frequency VERNIER** — Allows precision electronic control of the signal output frequency. A full turn of the control is approximately equal to 1% of full scale. When turned to the full cw position (CAL), settings on the frequency dial (3) will be calibrated.

3. **Frequency Dial** — The setting on this dial multiplied by the frequency range setting equals the output frequency of the generator. The frequency VERNIER also affects the generator frequency.

4. **Frequency Index** — Indicates the frequency dial (3) setting by reading the dial position opposite the scribe line on the frequency index. The index is illuminated when power to the unit is on.

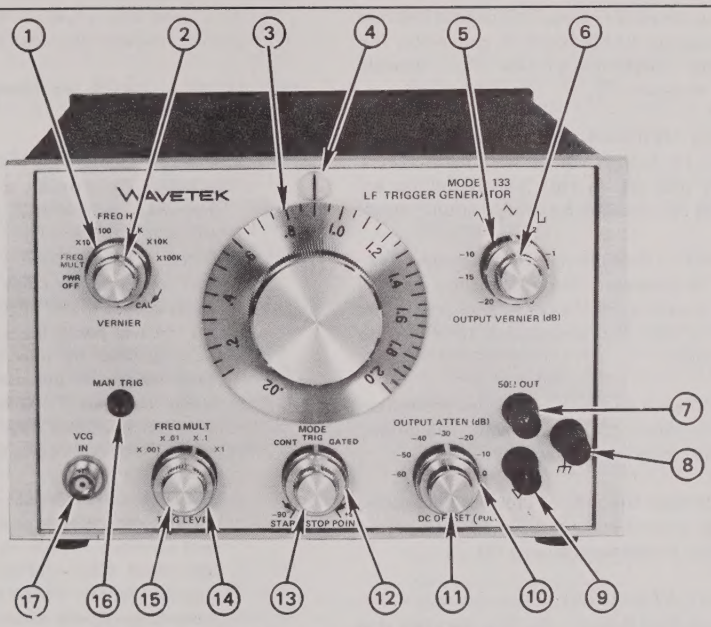


Figure 2-1. Front Panel Controls and Connectors

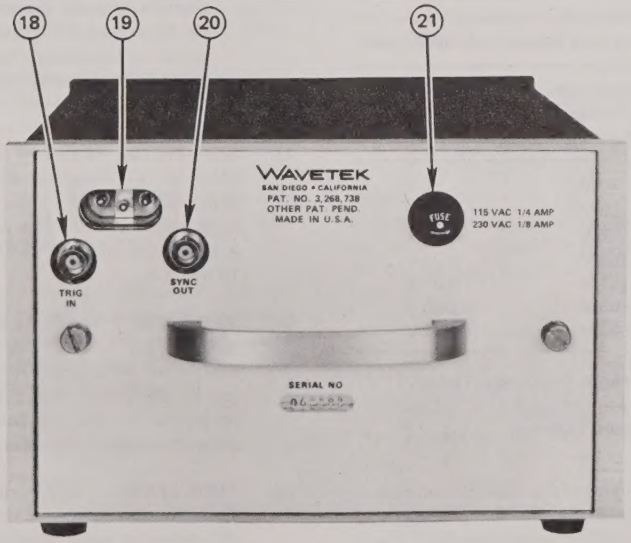


Figure 2-2. Rear Panel Connectors

5. **Function Selector** — Selects the desired function that appears at the 50Ω OUT (7) connector. The selectable waveforms are sine ∿ , triangle ∿ , or square ⊓ .

6. **OUTPUT VERNIER (dB)** — Provides vernier control of 0 through −20 dB from the OUTPUT ATTEN (dB) setting (10). This is the fine adjustment for attenuation of the output signal.

7. **50Ω OUT** — Provides the selected output function. The generator may operate into an open circuit providing 20 V peak to peak maximum, or into a 50Ω load providing a 10 V peak to peak output.

8. ⏚ **(Chassis Ground)** — Provides connection to chassis ground of the instrument. This ground is isolated from signal ground (9).

9. ▽ **(Signal Ground)** — Provides connection to signal ground in the instrument. This ground is isolated from chassis ground (8).

10. **OUTPUT ATTEN (dB)** — Attenuates the output signal from 0 dB to −60 dB in six calibrated 10 dB steps according to the following table:

Output Attenuator Position	Peak to peak Output into 50Ω Load	
	Maximum Vernier fully cw*	Minimum Vernier*
0 dB	10 V	1 V
−10 dB	3 V	0.3 V
−20 dB	1 V	0.1 V
−30 dB	0.3 V	0.03 V
−40 dB	0.1 V	0.01 V
−50 dB	0.03 V	0.003 V
−60 dB	0.01 V	0.001 V

*The values in this table are approximate. The OUTPUT VERNIER (dB) (6) will reduce the output approximately 20 dB in all cases, as shown.

11. **DC OFFSET** — When the knob is pulled out, this control adjusts the base line 5 V above or below ground (±2.5 V offset into 50Ω load). When knob is pushed in, the offset control is disconnected and normal vertical symmetry is provided. Peak amplitude is the signal peak plus the dc offset and should be less than ±5 V into a 50Ω load, or ±10 V into an open circuit; otherwise clipping will occur.

12. **MODE** — Selects the operating mode of the generator as follows:

    a. **CONT** = Continuous Mode — The generator operates continuously at the frequency determined by the dial and VCG settings.

    b. **TRIG** = Trigger Mode — The generator will give one complete cycle of output for each pulse applied to the TRIG IN (18) connector on the rear panel. Manual triggering can be accomplished by moving the MAN TRIG (16) switch to the down position. When using the MAN TRIG switch in this mode, the TRIG LEVEL (15) control should be set to the midpoint position.

    c. **GATED** = Gated Mode — Operates the same as triggered mode except that the generator will continue to have an output for the full period of time that an external signal is applied to the TRIG IN (18) connector. Manual gating can be accomplished by moving the MAN TRIG (16) switch to the down position, thereby generating a discrete number of cycles. When using the MAN TRIG switch in this mode, the TRIG LEVEL (15) control should be set to the midpoint position.

13. **START/STOP POINT** — Allows the starting point of the integrator to be varied through approximately ±90° when in the triggered, or gated mode. It should be noted that exceeding a start/stop point of +90° will cause the unit to free run.

14. **FREQ MULT** — Selects one of four decade ranges from X 0.001 to X 1 for generator frequency, when the FREQ HZ (1) switch is set to the FREQ MULT position. This value multiplied by the frequency dial setting (3) gives the output frequency of the generator.

15. **TRIG LEVEL** — In the trigger mode of operation, this control allows the operator to adjust the voltage at which triggering occurs or, in the gated mode, the minimum voltage above which gating occurs. When in the full ccw position, approximately +13 V is required for triggering. In the full cw position, approximately −13 V is re-

quired for triggering. At midpoint, a 1 V peak signal will trigger the instrument. When using the MAN TRIG (16) switch in the TRIG (12b) or GATED (12c) MODE, the TRIG LEVEL control should be set to the midpoint position.

16. **MAN TRIG** — Spring-loaded manual switch used to produce a single internal trigger pulse for generation of one cycle of the selected output waveform when in the TRIG MODE, or a discrete number of cycles when in the GATED MODE. The TRIG LEVEL (15) control should be set to the midpoint position.

17. **VCG IN** — Provides connection for external voltage control of frequency. Up to 1000:1 frequency change may be obtained. A positive voltage increases frequency and a negative voltage decreases frequency. (Refer to Operation as a Voltage Controlled Generator.)

Rear Panel

18. **TRIG IN** — DC coupled input with 10 kΩ input impedance. The TRIG LEVEL (15) control adjusts the sensitivity of the generator to this input signal. Input signal must be +1 V minimum peak. Up to 100 volts may be applied without damage to the input circuitry.

19. **Power In Receptacle** — Accepts a female power connector for applying 115 or 230 volts ac.

20. **SYNC OUT** — This output connector provides a synchronizing wave output at the same frequency of the generator. The output amplitude is greater than 1 V peak to peak into an open circuit at 600Ω output impedance.

21. **Line Fuse** — Protects the instrument from ac line transients as well as short circuits within the instrument. For 115 Vac operation, use a 1/4 ampere slow blow fuse. For 230 Vac operation, use a 1/8 ampere slow blow fuse.

OPERATION

NOTE

One-half hour warm-up is required for generator to stabilize at specified accuracies.

Operation as a Function Generator

1. Terminate 50Ω OUT connector with 50 ohm ±1%, 2 watt termination.
2. Select the desired waveform by setting function selector to sine ∿ , triangle ∿ , or square ⊓ .
3. Set frequency dial, FREQ HZ range multiplier and FREQ MULT selector for desired output frequency.

NOTE

When the FREQ HZ selector (higher frequency ranges) is used in the X 10 through X 100K positions, the FREQ MULT selector should be in the X 1 position; when the FREQ MULT selector (low frequency ranges) is used, the FREQ HZ selector should be in the FREQ MULT position.

4. Set MODE selector to CONT position for continuous wave operation.
5. Select output signal amplitude by setting OUTPUT ATTEN (dB) switch to appropriate attenuation position and fine adjusting signal to desired amplitude with OUTPUT VERNIER (dB) control.

Operation as a Voltage Controlled Generator

The VCG input connector can be used to externally control the frequency of the generator. If a positive voltage is applied to the VCG input terminal, the frequency will increase from the dial setting. A negative voltage will cause the frequency to decrease from the dial setting. The VCG range of the Model 133 is 1000:1.

1. Terminate 50Ω OUT connector with 50 ohm ±1%, 2 watt termination.
2. Select the desired waveform by setting function selector to sine ∿ , triangle ∿ , or square ⊓
3. Set FREQ HZ or FREQ MULT selector for desired output frequency.
4. Connect external voltage source (dc programming or wide-band ac signal) to VCG IN connector.

NOTE

VCG input requires 0 to ±5 volts for operation over full-scale range, but can withstand ±20 V maximum input.

5. Set frequency dial as follows:

   a. For frequency modulation with ac input, set dial for center frequency.
   b. For increasing frequency sweep with positive dc input, set dial to lower frequency limit.
   c. For decreasing frequency sweep with negative dc input, set dial to upper frequency limit.

6. To sweep the audio range from 20 Hz to 20 kHz, set the controls to 20 Hz as follows:

   a. Set FREQ HZ selector to X 10K position.
   b. Set the frequency dial to 0.02.
   c. Adjust the frequency VERNIER to achieve 20 Hz.
   d. Introduce a 0 to +5 V ramp into the VCG input connector.

The maximum frequency that can be obtained, when using the VCG input, is the FREQ HZ range multiplier times the maximum frequency dial setting (2.0). The minimum frequency is the FREQ MULT selector times 0.002. (Frequency dial must be set at 0.02 and frequency VERNIER must be in ccw position.) The nomograph in Figure 2-3 shows the characteristics of the VCG circuit. Column A gives the frequency dial setting; column B, the VCG input voltage; and column C, the approximate resultant dial frequency. Column C must be multiplied by the frequency range multiplier for the actual output frequency.

In example 1, the frequency dial is set at 1.0, and 0 volt is applied to the VCG input. Extend a straight line from 1.0 through 0 volt (VCG IN voltage) and obtain a dial frequency factor of 1. For the total output frequency, multiply the range setting by 1.0. Example 2 shows the results of using a ramp from −1 volt to +2.5 volts for the VCG voltage. This gives a swept output factor from 0.6 to 2.0. Remember to multiply the factor with the range setting for actual frequency.

Operation as a Triggered/Gated Generator

The Model 133 generator may be operated as a triggered/gated generator using an internal signal that is manually triggered from the front panel, or an external triggering signal of +1 V peak minimum. The maximum signal applied to the input circuitry should not exceed 100 volts.

1. Set MODE selector to TRIG or GATED position.
2. Set function selector to desired waveform.
3. Set generator to the desired frequency.
4. Connect external signal to TRIG IN connector (rear panel), if external triggering is desired.
5. Select the point on the triggering waveform by varying the TRIG LEVEL control, when in the TRIG MODE. In the GATED MODE, set the duration of the burst (number of cycles per gating signal) by varying the TRIG LEVEL control.
6. Set START/STOP POINT control to desired base line on waveform.

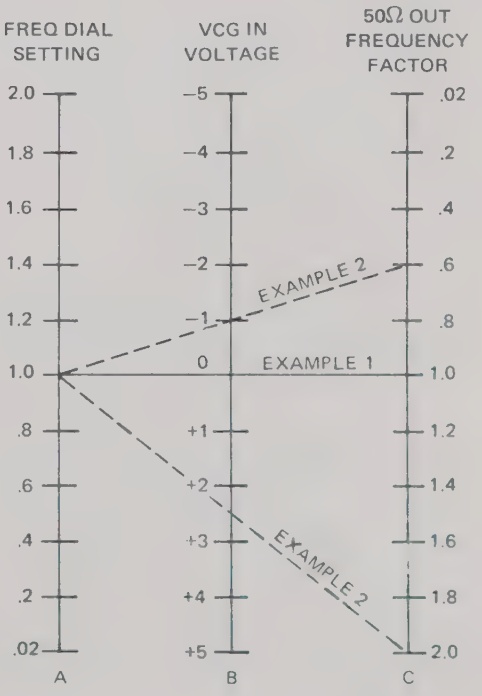


Figure 2-3. VCG Voltage-to-Frequency Nomograph

Operation as a DC Voltage Source

The Model 133 generator may be used as a variable voltage source not to exceed 100 mA of current as follows:

1. Set function selector to ∿ position.
2. Set MODE selector to TRIG position.
3. Set OUTPUT ATTEN (dB) and OUTPUT VERNIER (dB) controls to 0 position.
4. Set TRIG LEVEL control to midpoint.
5. Connect the 50Ω OUT connector to the device requiring dc voltage.
6. Adjust dc voltage level by turning START/STOP POINT control. This will provide dc output of ±10 volts maximum.

Converting to 230-Volt Line Power

Model 133 is shipped from the factory with the internal 115/230 switch set to 115 volts, unless ordered for 230-volt use. To convert from 115-volt to 230-volt operation, proceed as follows:

1. Remove power cord.
2. Loosen two captive thumb screws on rear cover and remove cover.
3. Replace 1/4-ampere fuse with 1/8-ampere fuse of the same type.
4. Move the 115/230 switch to the 230 position by inserting a screwdriver in the slot and moving the switch to the right.

Connecting Signal and Chassis Grounds

The instrument is shipped from the factory with the signal ground isolated from chassis ground, unless otherwise specified. A common signal/chassis ground can be obtained by connecting a jumper wire between the signal ground ⏚ and chassis ground ⏚ connectors on the front panel.

Converting Output Impedance to 600 Ohms

Unless otherwise specified, this instrument was shipped with 50 ohm output impedance, but can be converted to 600 ohm output, if needed. Place a 549Ω ±1%, 1/4 watt or higher power rating resistor in series with the wire leading from the 50Ω OUT binding post and the attenuator switch.

SECTION 3
CIRCUIT DESCRIPTION

CIRCUIT DESCRIPTION

Refer to Figure 3-1 for a block diagram of the Model 133 Low Frequency Trigger Generator.

The basic generator circuitry consists of the integrator and hysteresis/output switch. From the output switch, a square wave is applied to the VCG circuit. The VCG circuit gates a current that is proportional to

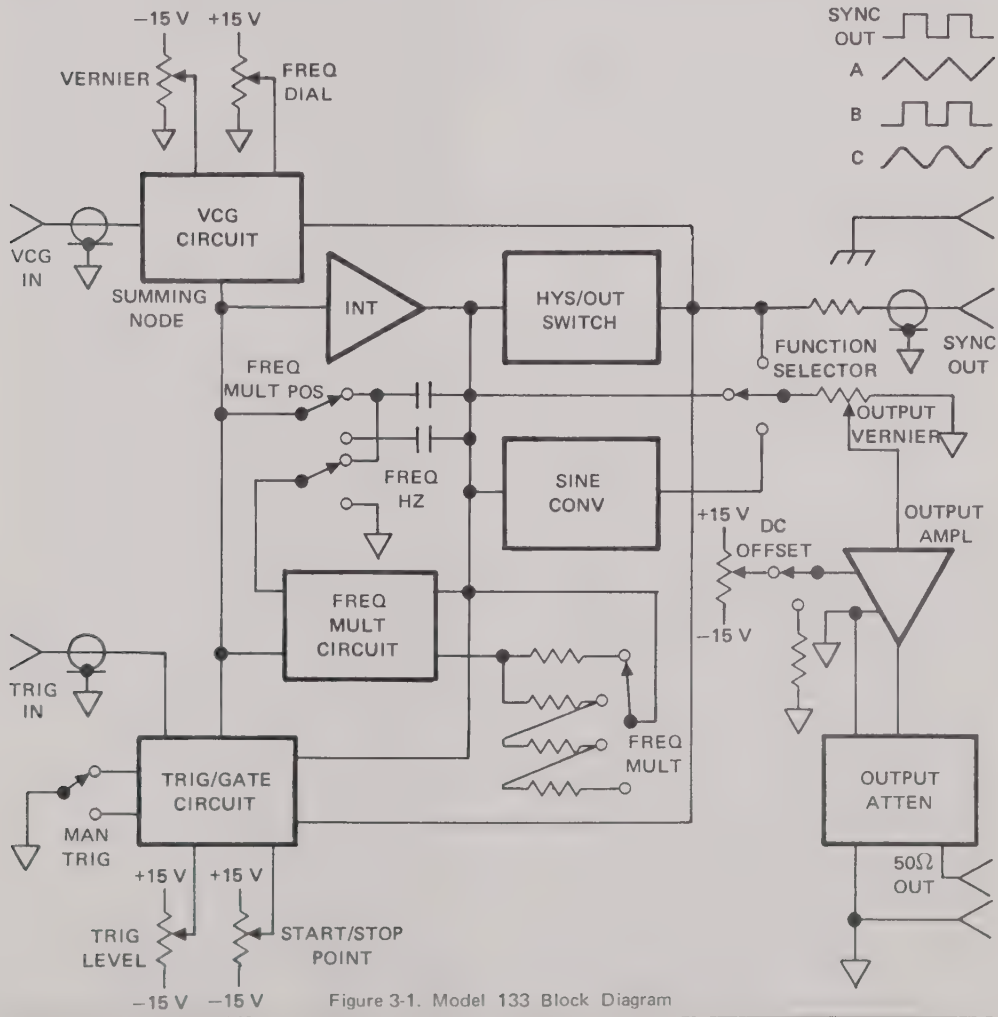


Figure 3-1. Model 133 Block Diagram

the sum of the VCG input, frequency dial, and VERNIER control voltages into the integrator summing node. Current flow in and out of the summing node is transformed by the integrator into a triangle wave that is applied to the hysteresis switch. The function of the hysteresis/output switch is similar to a Schmitt trigger with its limits set far apart. When a limit point is reached, the hysteresis/output switch fires and reverses the polarity of the square wave, causing current to flow into the integrator. This produces triangle waves of the same frequency, with the positive portion of each square wave coincident with the negative slope of each triangle wave.

The magnitude of the capacitor across the integrator and amplitude of the current into the integrator determine the frequency of oscillation. Capacitance across the integrator is changed by rotating the frequency Hz selector. Amplitude of the current into the integrator is determined by three parameters which are summed into the VCG circuit: (1) the frequency dial voltage, (2) the frequency vernier voltage, and (3) the VCG input voltage.

The sine wave is generated by feeding the triangle wave into a shaping network composed of resistors and diodes. As the triangle wave voltage passes through zero, loading of the triangle wave is minimal and thus the slope is maximum. As the triangle voltage increases, diodes with current limiting resistors conduct and successively cause the slope of the output signal to be reduced.

Since the diode break points are mathematically computed and fitted to the true sine shape, the resultant waveform is close to being a pure sine wave. Complementary pairs of diodes are used at each break point to make the waveform completely symmetrical about ground. The sine wave generated by shaping is considerably less in amplitude than the triangle wave input and is amplified to be equal to the triangle wave.

The triangle wave output of the integrator and the square wave from the output switch pass through their respective dividers. Both of these signals and the sine wave output are fed to the function selector switch. The switch is coupled to the amplitude control on the front panel which, in turn, is connected to the input of the output amplifier. A precision step attenuator is placed between the output amplifier and the 50Ω OUT terminals.

In the TRIG or GATED MODE, the trigger circuit feeds a current into the summing node of the integrator to hold the output at the dc level set by the START/STOP POINT control. The start/stop point of the trigger or gated output can be adjusted by front panel control to occur anywhere between ±90°. When a trigger signal is received, the trigger circuit permits the integrator to operate for one full cycle. When a gating signal is received, the integrator runs until the trigger signal is removed and the cycle is completed. Trigger and gating signals can be generated internally by using the MAN TRIG switch, or externally by using the TRIG IN connector and TRIG LEVEL control.

When the FREQ MULT selector is in use, the frequency multiplier circuit differentiates the output of the integrator and subtracts current, by the maximum amount selected by the FREQ MULT selector, from the summing node. Thus, the effective integrating current is reduced. The result is the generation of lower frequency waveforms, without increasing the value of the integrating capacitors.

All instrument circuits, except the hysteresis/output switch circuit, output stage of the power amplifier, and part of the trigger circuit, operate with a regulated ±15 V supply. The hysteresis/output switch circuit requires a regulated ±6 V supply; the power amplifier output stage requires an unregulated ±22 V supply; and the trigger circuit requires a regulated +5 V supply.

SECTION 4
MAINTENANCE

INTRODUCTION

This section provides instructions for testing, calibrating, troubleshooting, and repairing the Model 133. The instructions are concise and for the experienced electronics technician or field engineer. Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to facilitate the turn-around time. Test point and adjustment locations are illustrated in Section 5.

RECOMMENDED TEST EQUIPMENT

Table 4-1 contains a list of recommended test equipment. Any test equipment having equivalent accuracies may be substituted for those listed.

Table 4-1. TEST EQUIPMENT

Instrument	Required Characteristics
Oscilloscope	To 30 MHz.
Dual channel plug-in	Dual channel.
Comparator plug-in	5 mV measuring capability with 3.75V offset. 5% accuracy.
Distortion analyzer	10 Hz to 600 kHz. 0.1% full scale THD measuring capability.
Differential voltmeter	$Z_{IN} \geqslant 100$ MΩ. 30 μV full scale measuring capability. 1% accuracy.
Counter	4 digits. To 1 MHz. 0.01%-of-reading accuracy.
Digital voltmeter	3½ digit. 0.1% accuracy.

CHECKOUT AND CALIBRATION

The following paragraphs provide complete sequential calibration procedures for the Model 133. A quick checkout of the instrument can be performed by comparing the indicated parameters with the tolerances given in the Specifications of Section 1.

NOTE

The entire calibration procedure must be read first to determine initial control settings and test equipment connections before attempting checkout.

Preliminary Procedures

1. Set FREQ HZ selector to the X 1K position, frequency dial to 2.0, and VERNIER control to CAL position.
2. Set MODE selector to CONT position, START/STOP POINT control to mid-range, FREQ MULT selector to X 1 position, and TRIG LEVEL control to maximum ccw position.
3. Set OUTPUT VERNIER (dB) and OUTPUT ATTEN (dB) selectors to 0 position and push in DC OFFSET control.
4. Allow one-half hour for warm-up.

NOTE

Refer to Removal of Dust Covers and Panels in this Section for access to adjustments.

Power Supply Regulation

1. Connect voltmeter between TP1 (common) and TP2 (+) on main board. Adjust R104 for +15 Vdc ±100 mV.
2. Connect voltmeter between TP1 (common) and TP3 (−). Since the negative supply is referenced to the +15 volt supply, the voltmeter should indicate −15 V ±100 mV.
3. Check the +5 volt supply on the trigger board for +5 V ±200 mV.

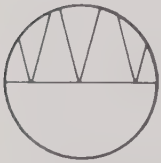
Square Wave Amplitude Symmetry

1. Set function selector to ⊓ .

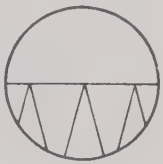
2. Connect oscilloscope, with plug-in (peak mV measuring capability), to coaxial wire lug on function switch.
3. Using a comparator plug-in, set the positive peak to the center of the oscilloscope. Switch the comparator to the negative peak and adjust R121 so that the negative peak equals the positive peak.

Triangle Amplitude

1. Set function selector to ∿ .
2. Connect oscilloscope, with comparator plug-in (peak mV measuring capability), to junction of R38 and R39 resistors on main board.
3. Adjust R56 on main board for positive peak at +3.750 V ±5 mV. (See sketch.)
4. Adjust R59 for negative peak at −3.750 V ±5 mV.



Negative Peak



Positive Peak

Output Amplifier

1. Connect oscilloscope to 50Ω OUT connector with 50 ohm terminator loaded at oscilloscope (⊓⊔ function).
2. Turn OUTPUT VERNIER (dB) control fully ccw.
3. Adjust R150 for amplitude symmetry about ground.
4. Set function selector to ∿ . Set sine wave symmetry about ground by adjusting R128.
5. Set sine wave amplitude equal to square wave amplitude by adjusting R133.
6. Set FREQ HZ selector to X 100K position.
7. Turn OUTPUT VERNIER (dB) control to CAL position. Set function selector to ⊓⊔ .
8. Adjust C64 to provide a rise time of 50 ns.

First VCG Null

1. Set FREQ HZ selector to X 100K. Set frequency dial to 0.02.
2. Short and open VCG IN to signal ground (outside of BNC) while monitoring output frequency variation. Adjust R11 for minimum frequency change.

Time Symmetry

1. Connect unit and oscilloscope, with dual channel plug-in set for alternate display, as shown in Figure 4-1.
2. Set FREQ HZ selector to X 100K with frequency VERNIER in CAL position (⊓⊔ function).
3. Set frequency dial to 0.02.
4. Adjust R28 for time symmetry.
5. Turn frequency VERNIER fully ccw and adjust R22 for time symmetry.

NOTE

Interaction occurs between R28 and R22. Repeat steps 4 and 5 until 1% symmetry accuracy is met. (If the square wave has a period equal to 10 cm, switching in the X 10 magnification on the oscilloscope will give 1 cm = 1%.)

6. Check for waveform time symmetry at the 0.2 and 2.0 frequency dial settings.
7. Check to assure FREQ HZ selector is set to X 100K position with frequency VERNIER turned fully ccw.
8. Turn frequency dial fully cw, then fully ccw and check for a 1000:1 frequency ratio. Adjust R8, if necessary, for slightly greater than 1000:1 ratio.

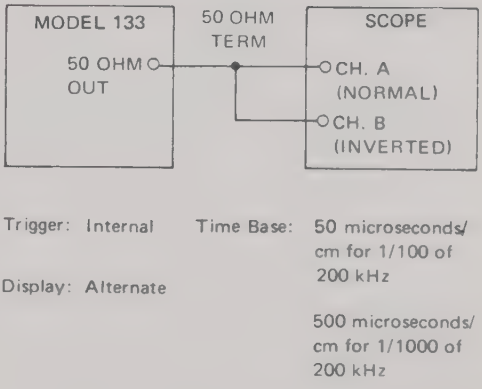


Figure 4-1. Time Symmetry Measurement for Test Setup

Frequency Calibration

1. Connect counter to 50Ω OUT connector.
2. Set frequency VERNIER to CAL position, frequency dial to 2.0, and FREQ HZ selector to 1K position.
3. Adjust R4 to provide a frequency of 2.0 kHz.
4. Set FREQ HZ selector to X 10K and frequency dial to 2.0.
5. Adjust C16 to obtain 20 kHz on counter display.
6. Set FREQ HZ selector to X 100K. Adjust C12 to obtain 200 kHz ±2 kHz on counter display.

Sine Distortion

1. Set frequency VERNIER to CAL position, frequency dial to 2.0 and function selector to ∿ .
2. Connect unit, distortion analyzer, and oscilloscope as shown in Figure 4-2.
3. Set FREQ HZ selector to X 1K position.
4. Adjust R126 and R127 for minimum sine distortion (less than 0.5%).
5. Set FREQ HZ selector to X 10K position.
6. Repeat step 4.
7. Repeat steps 3 through 6 until minimum sine distortion appears at both ranges.
8. Set FREQ HZ selector to X 100K position, frequency dial to 2.0, and check to assure distortion at 200 kHz does not exceed 1%.

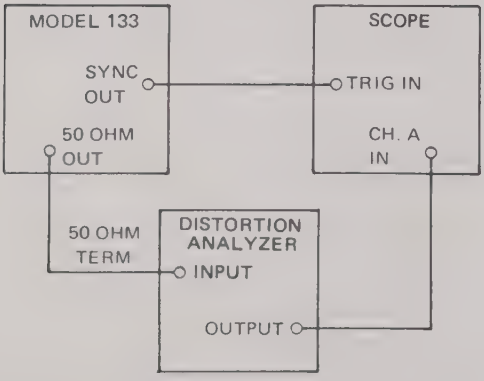


Figure 4-2. Distortion Analysis Test Setup

Trigger Board

1. Set FREQ HZ selector to FREQ MULT position, MODE selector to TRIG position, and frequency dial to 0.02.
2. Connect 50Ω OUT connector to the oscilloscope and check to assure generator has stopped running. Set STOP/START POINT control for 0 Vdc.
3. Set FREQ MULT selector to X 0.1 position. Connect voltmeter between the junction of C16 and C17 (5 μf capacitors) and R41 on the trigger board and the wiper of switch 6-A. Place a 10 kΩ resistor in each lead to prevent loading the circuit with the meter leads.
4. Adjust R46 to provide voltage difference of less than ±20 μV.
5. Connect 50Ω OUT connector to counter; set MODE selector to CONT position, FREQ MULT selector to X 0.1 position, and frequency dial to 2.0.
6. Adjust R39 to provide a period of 5.0 seconds.

TROUBLESHOOTING

Basic Techniques

Troubleshooting the Model 133 requires no special technique. Listed below are a few reminders of basic electronic fault isolation.

1. Check control settings carefully. Many times an incorrect control setting, or a knob that has loosened on its shaft, will cause a false indication of a malfunction.
2. Check associated equipment connections. Make sure that all connections are securely connected to the correct connector.
3. Perform the checkout procedure. Many out-of-specification indications can be corrected by performing specific calibration procedures.
4. Visually check the interior of the instrument. Look for such indications as broken wires, charred components, and loose leads.

Troubleshooting Chart

Table 4-2 provides a list of possible malfunction symptoms, their probable causes, and the prescribed remedies. Also listed in this table are the test points at which measurements are to be made and the parameter tolerances at these points. To use the Troubleshooting Chart, locate the symptom listed in Column 1 and fol-

low the corresponding procedures. Localize the fault to a specific stage by checking the parameters given for the major test points. Then check the dc operating voltages at the pins of solid-state devices. Check associated passive elements with a high input impedance ohmmeter (power off) before replacing a suspected semiconductor element.

Troubleshooting Hints

GENERATOR LOOP

The interactive nature of a closed loop presents a somewhat special problem when approached from a troubleshooting standpoint. The simplest way to reduce problem complexity is to open the loop, thereby removing the interaction. The basic units of the loop can then be tested individually. The following step-by-step procedure describes how this is done. (The generator loop is all contained on the main board.) Consult next paragraph for removal of cover and panels.

1. Set instrument controls for 20 V p-p, 2 kHz sine wave output.
2. Check at coaxial wire lug of function selector switch for a 2.5 V p-p square wave. If normal, check output amplifier (Q34 - Q40).
3. Unsolder and lift the end of R51 (TP7). This is the output of the integrator and input to the hysteresis switch. The generator loop has now been opened.
4. Inject a 7.5 V p-p triangle waveform into the hysteresis switch input lead (TP7).
5. Check at the coaxial wire lug of the function selector switch for a 2.5 V p-p square wave at the injected frequency.

   a. If present, hysteresis and output switches are functioning correctly. Proceed to step 6.
   b. If abnormal, check Q6 - Q16 stages.

6. Vary frequency dial from ccw to cw while observing TP11 with an oscilloscope. Voltage at this point should remain at 0 volts throughout dial rotation. If a voltage variation is observed, check IC1 stage.
7. Vary frequency dial from ccw to cw while observing TP4. Voltage reading should vary from 0 to approximately −6 volts. If voltage does not vary, check IC1 and IC2 stages.
8. Vary frequency dial from ccw to cw while observing TP9. Voltage reading should remain at 0 volts. If voltage varies, check IC3 stage.
9. Vary frequency dial from ccw to cw while observing TP10. Voltage should vary from 0 volts to approximately +6 volts. If voltage does not vary, check IC2 and IC3 stages.
10. Vary frequency dial from ccw to cw while observing TP8. Voltage reading should remain at 0 volts. If voltage varies, check IC9 stage.
11. Re-install R51.

TRIGGER BOARD

The generator can be operated with the trigger board removed. Unplug all AMP pins and connect the oscilloscope to AMP pin VV (amplifier output on the main board). The instrument can be operated as a function generator with the exception of the output attenuator, trigger and capacitance multiplier.

Table 4-2. TROUBLESHOOTING CHART

Symptom	Probable Cause	Corrective Procedures
No outputs at 50Ω OUT connector	Blown fuse	Replace F1. a. 1/4A — 115 Vac b. 1/8A — 230 Vac
	Power supply	Check TP1/TP2 for +15 V, TP1/TP3 for −15 V, TP1/TP5 for +6 V, TP1/TP6 for −6 V. Troubleshoot associated voltage regulator.

Table 4-2. TROUBLESHOOTING CHART (Continued)

Symptom	Probable Cause	Corrective Procedures
	Output amplifier	Check at wiper (grn/wht wire) of function selector switch for waveform as selected by position of switch. a. If waveform is present, troubleshoot output amplifier. b. If no waveforms are present, refer to Troubleshooting Hints.
No sine wave output	Sine amplifier	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If present, check IC8 circuit. *NOTE* *Triangle wave must be present at pin 2 of A1 to obtain sine wave output.* b. If not present, check A1 circuit.
No triangle, sine, or square wave	Generator loop	Refer to Troubleshooting Hints.
All waveforms low in amplitude	Power amplifier	a. Check front panel amplitude control. b. Perform balance adjustment for power amplifier.
	Power supply	Check for correct voltages.
Frequency out of tolerance	Power supply	Check for correct power supply voltages as stated above.
	Maladjustment	Perform calibration procedure.
Sine wave not in spec	Maladjustment	Perform sine distortion, amplitude, and balance adjustments.
	Sine converter	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If normal, check sine amplifier IC8. b. If abnormal, check A1 circuit.
Time symmetry of waveforms not correct	Maladjustment	Perform time symmetry and frequency adjustments.
Generator continues to run in TRIG or GATED MODE with no input signal	TRIG LEVEL or START/STOP POINT control in wrong position	Check position of all control settings.

Table 4-2. TROUBLESHOOTING CHART (Continued)

Symptom	Probable Cause	Corrective Procedures
Trigger circuit not working	+5 V supply	Check output of IC6 for +5 V ±200 mV.
	Trig/sync circuit	Check for a negative-going pulse out of IC1(A) pin 5. a. If no pulse, check trig/sync circuit. b. If pulse is present, check start/stop circuit.
	Start/stop circuit	If start/stop circuit gets a positive-going pulse from IC1 pin 5, IC3 should turn on and hold the integrator at the level set by R29.
No low frequency output	Capacitance multiplier not working	Capacitance multiplier is not active in the X 1 position and generator should run at X 1 with trigger board unplugged.

REMOVAL AND REPLACEMENT

Replacement of Switch Wafers and Potentiometers

1. To replace FREQ HZ switch wafer C or D or the VERNIER potentiometer, proceed as follows:

   a. Remove rear panel and dust cover as previously described.
   b. Separate bracket assembly from chassis as previously described.
   c. Tag and unsolder leads to part being replaced.
   d. Pull defective part off shaft and repair or replace with recommended replacement part.

2. To replace FREQ HZ switch wafer A or B, proceed as follows:

   a. Remove rear panel and dust cover as previously described.
   b. Remove front panel as previously described.
   c. Tag and unsolder wires to switch wafers A and B.
   d. Unsolder wafer B PC-tabs from printed circuit board.
   e. Lift switch shaft slightly to free PC-tabs; rotate switch shaft so wafers clear board parts; and pull shaft end free of rear-mounted wafers C and D.
   f. Repair or replace defective part.

3. To repair or replace function selector wafers or 20 V p-p max potentiometer, proceed as follows:

   a. Remove rear panel and dust cover as previously described.
   b. Loosen setscrews holding potentiometer and switch knobs to inner and outer shafts and remove knobs.
   c. Tag and unsolder wires to defective part.
   d. Unsolder potentiometer PC-tabs; lift shaft slightly to free tabs; rotate switch shaft so wafers clear board parts; and pull switch/potentiometer assembly out of front panel hole.
   e. Repair or replace defective part.

Replacement of Sine Converter

1. Remove rear panel and dust cover as previously described.
2. Unsolder the five pins of sine converter A1 from top of the printed circuit board, using a solder syringe.
3. Lift assembly from bottom of the board; a thin pencil-type soldering iron can be used, if necessary, to apply temporary heat during removal.

Removal of Dust Covers and Panels

1. To gain access for calibration or maintenance, proceed as follows:

   a. Remove power cord.
   b. Loosen the two knurled captive screws on the rear panel.
   c. Pull off the rear panel.

d. Remove the cover.

2. To gain access to any part mounted on bracket assembly behind rear panel, proceed as follows:

   a. Remove rear panel and dust cover as described in step 1 above.
   b. Remove one heat-sink mounting screw.
   c. Remove bottom transformer mounting-block screw.
   d. Remove the two screws, lock washers, and hex nuts holding two wafers of FREQ HZ switch to bracket assembly.
   e. Remove four bracket assembly retaining screws.
   f. Carefully pull bracket assembly to rear to obtain working room. Enough slack is available in the wiring for all normal operations.

3. To remove the front panel, proceed as follows:

   a. Remove rear panel and dust cover as described in step 1.
   b. Remove all knobs.
   c. Unscrew frequency dial potentiometer retaining nut.
   d. Unsolder ground bus wire and BNC connector.
   e. Remove light bulb from indicator lens.
   f. Remove four front panel retaining screws and carefully pull off front panel.
   g. Unbolt coaxial cable from 50Ω OUT connector (green - chassis ground) and unsolder MAN TRIG switch.

4. To remove trigger board for access to bottom of main or trigger board, proceed as follows:

   a. Remove the six knobs from the switches mounted on the trigger board.
   b. Unsolder bus wire from attenuator switch to the signal ground terminal.
   c. Remove four mounting screws on side panels and pull trigger board to the rear.
   d. Unbolt solder lug on 50Ω OUT terminal.
   e. Unplug coaxial cable connecting attenuator switch to main board.
   f. Lift end of trigger board until board stands upright giving access to the bottom of both boards.

SECTION 5
DATA PACKAGE

INTRODUCTION

This Section contains data packages for the Model 133. Each data package is a quick-access document, containing maintenance data arranged for convenient viewing of the schematic diagram and all supporting data. Each data package includes a parts-location illustration, voltage/waveform data and a schematic diagram. Voltage and waveform data are provided on the diagrams at indicated test points as an aid to troubleshooting. All parts lists, used in conjunction with the parts-location illustration, are located at the end of this Section.

RECOMMENDED SPARE PARTS LIST

Information is provided to maintain the instrument on a component level. Price and delivery information should be obtained from the Wavetek representative in your area, or directly from the factory.

DESCRIPTION	MANUFACTURER	PART NO.	QTY
DIODE	FAIRCHILD	FD6666	2
DIODE	SEMTECH	SCE-1	2
DIODE	WAVETEK	130-506	1
DIODE	HEWLETT PACKARD	HP5082-2811	1
FUSE 1/8A 230 V	LITTELFUSE	313-125	2
FUSE 1/4A 115 V	LITTELFUSE	313-250	
IC	RCA	*CA3030 (-16)	1
IC	RCA	*CA3039 (-18)	1
IC	NATIONAL SEMICONDUCTOR	LM301A	1
IC	MOTOROLA	MFC4060	1
IC	MOTOROLA	SN7474	1
IC	FAIRCHILD	*μA709C (-13)	1
IC	FAIRCHILD	μA715C	1
LAMP	MURA	L28/40	1
SINE MODULE	WAVETEK	B130-011	1
TRANSISTOR	FAIRCHILD	LO8	1
DUAL TRANSISTOR	SPRAGUE	TD 101	1
TRANSISTOR	TEXAS INSTRUMENTS	*TIP 29 (130-316)	1
TRANSISTOR	TEXAS INSTRUMENTS	*TIP 30 (130-316)	1
TRANSISTOR	TECHNICAL PRODUCTS	TP 308	1
TRANSISTOR	FAIRCHILD	2N2219A	1
TRANSISTOR	FAIRCHILD	2N2369	1
TRANSISTOR	FAIRCHILD	2N2905	1
TRANSISTOR	FAIRCHILD	2N2905A	1
TRANSISTOR, MATCHED PAIR	FAIRCHILD	*2N2905 (-8)	2
TRANSISTOR	FAIRCHILD	2N3299	1

DESCRIPTION	MANUFACTURER	PART NO.	QTY
TRANSISTOR	FAIRCHILD	2N3638	1
TRANSISTOR, MATCHED PAIR	FAIRCHILD	*2N3638 (-9)	2
TRANSISTOR	FAIRCHILD	2N3640	1
TRANSISTOR, MATCHED PAIR	FAIRCHILD	*2N3640 (-10)	2
TRANSISTOR	FAIRCHILD	2N3646	2
TRANSISTOR, MATCHED PAIR	FAIRCHILD	*2N3646 (-11)	2
TRANSISTOR	MOTOROLA	2N3903	1
TRANSISTOR	MOTOROLA	2N3905	1

*Denotes special parts that should be ordered from Wavetek. These parts have been tested, selected, and/or modified by Wavetek for optimum performance as follows.

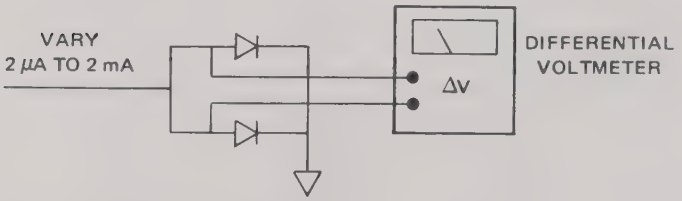
-1, 2 & 70 Resistors of the same value matched to within 0.1% of each other.

-8, 9, 10 & 11 All transistors of the same type have h_{FE}'s (Betas) matched to 10%. 2N2905's matched to $<$10 mV difference of V_{BE}; $V_{CES} > 50$ V.

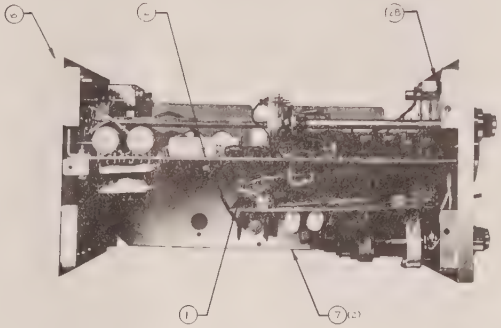
-13 Minimum output voltage swing of ±10 V (R_L = 2 kΩ). Maximum input offset voltage of 3 mV. Maximum input noise of 15 μV p-p (with no step noise). Maximum input bias current of 300 mA.

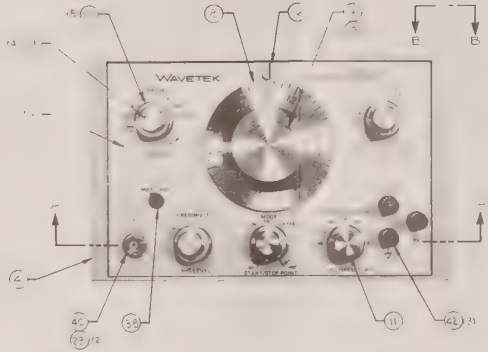
-16 Minimum output voltage swing of ±6 V. Maximum input offset voltage of 5 mV.

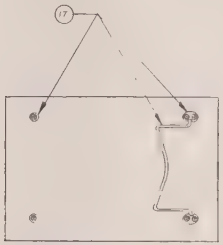
-18 Check match of diodes two at a time. All must meet the following criteria:



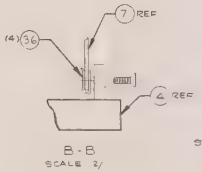
Input: 200 μA to 2 mA, ΔV: ⩽1.5 mV
2 μA to 2 mA, ⩽3 mV







VIEW-CHASSIS COVER
BOTTOM



B-B
SCALE 2/

A-A

F	ECN 348	DL	1-27-83	
E	ECN 307	ED	11-7-82	
D	ECN 1226	PL	7-14-82	
C	ECN 788	BA	3/8/78	JH
B	ECN C693	CDG	7-10-78	JH
A	ECN 478	JH	3/8/78	JH
rev	ecn	by	date	appd

tolerance unless otherwise specified
.XXX ± 0.0
.XX ± 0.00

WAVETEK san diego ca

scale

date 4 10 72 appd

material

title
CHASSIS ASSY

finish

model no 133 | dwg no & rev D133-000 | cur E | rev F

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⚠ ITEM NOT SHOWN ON ASSY PICTORIAL

NOTES

PARTS LIST

LINE NO	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	TRIG/MULT BOARD ASSY	WAVETEK	23338	D133-011	1
2	MAIN BOARD ASSY	WAVETEK	23338	D133-010	1
3	FRONT PANEL	WAVETEK	23338	133-300	1
4	FRONT CASTING	WAVETEK	23338	133-301	1
5	REAR PANEL	WAVETEK	23338	D133-303	1
6	REAR CASTING	WAVETEK	23338	D133-304	1
7	SIDE PLATE	WAVETEK	23338	C130-304	2
8	DIAL	WAVETEK	23338	D130-333	-
9	DIAL KNOB	WAVETEK	23338	D130-308	1
10	COAXIAL KNOB	WAVETEK	23338	D130-309	1
11	SMALL KNOB	WAVETEK	23338	A130-154	5
12					
13	POTENTIOMETER	WAVETEK	23338	A131-81A	1
14	COVER	WAVETEK	23338	C130-333	1
15	COVER SUPPORT	WAVETEK	23338	A130-336	1
16	DIAL INDICATOR	WAVETEK	23338	A141-317	1
17	BAIL KIT	WAVETEK	23338	D130-307	1
18					
19					
20					
21	BUSHING	THOMSON	96881	4L2PP	5
22					
23	SHOULDER WASHER	H.H. SMITH	83330	2668	2
24					
25	CAPTIVE SCREW	DEVSTCH	08574	7900-10-8-1	7

PARTS LIST

LINE NO	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
26	FASTENER	TINNERMAN	78553	CFNW-632-4	5
27					
28	RETAINER	TARMAC	79136	5305-31	1
29					
30	POWER CORD	BELDEN	70903	17258-5	1
31					
32	FASTENER	CARR	85058	PCN7291	2
33					
34	CHASSIS FASTENER	USECO	88245	.5910	4
35					
36	CAPTIVE FASTENER	TINNERMAN	78553	C 8091-632	4
37					
38	SWITCH (SPST)	C & K	09353	7108PDCN	1
39					
40	BNC CONNECTOR	KINGS	91836	KC7946	1
41					
42	BINDING POST	SUPERIOR	58474	DF21BC	3
43					
44	SOLDER LUG	H H SMITH	83330	1497	1
45					
46	SOLDER LUG	H. H. SMITH	83330	1494-6	3
47	SHOULDER WASHER	H. SMITH		2660	2
48	FLAT WASHER	H. SMITH		2269-N-385	3
49					
50					

SEE SHT 1

REV	ECN	BY	DATE	APP
A	ECN #478	[illegible]	10 Feb 76	

TOLERANCE UNLESS OTHERWISE SPEC
XXX ± .010
XX ± .020
ANGLES ± 2°

WAVETEK
SAN DIEGO CALIFORNIA

SCALE —
BY B. Stroud DATE 8 8 73 APP [illegible]

MATERIAL —

TITLE
CHASSIS ASSY

FINISH —

MODEL NO 133 | DWG NO D133-000 | REV F

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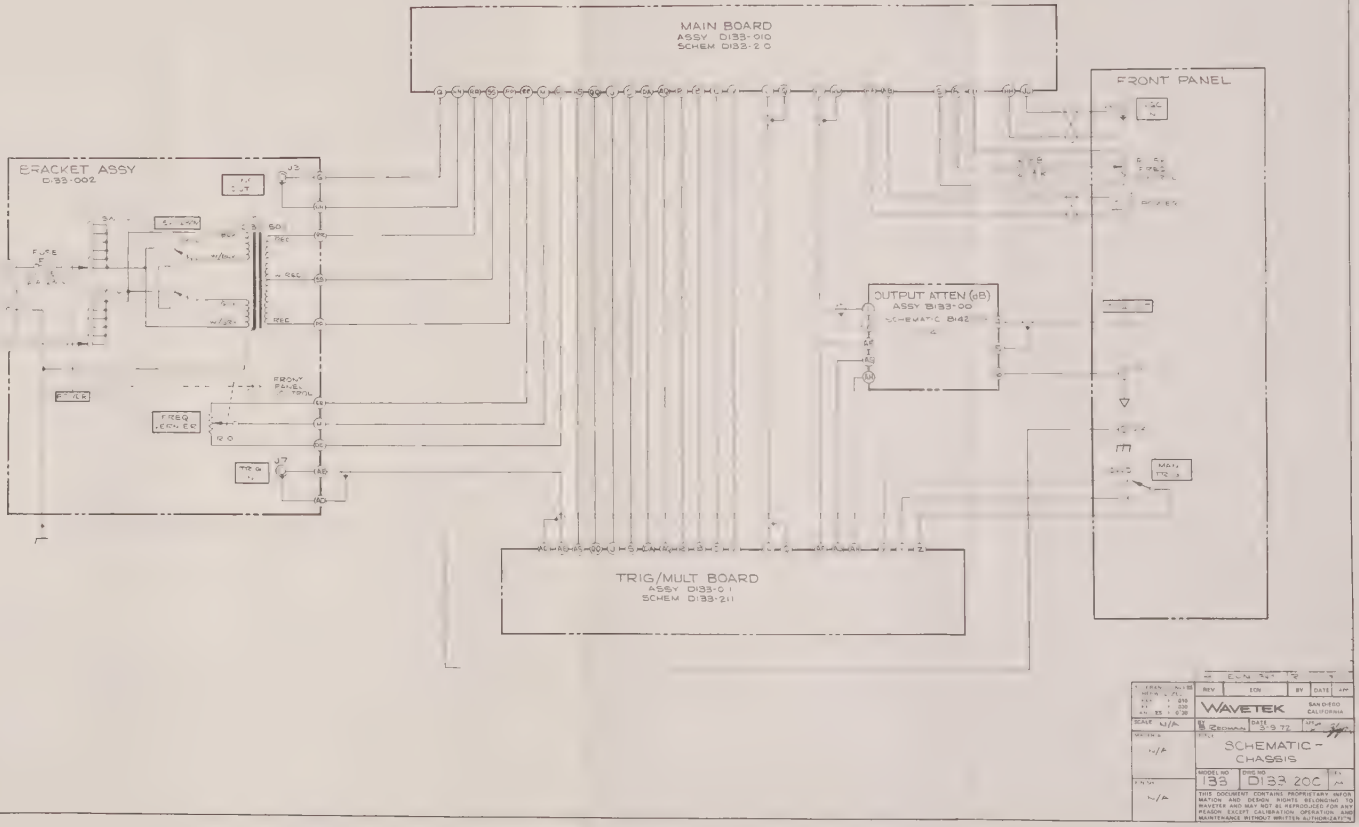
MAIN BOARD
ASSY D133-010
SCHEM D133-20
FRONT PANEL
BRACKET ASSY
D133-002
OUTPUT ATTEN (dB)
ASSY D133-00
SCHEMATIC D142
TRIG/MULT BOARD
ASSY D133-01
SCHEM D133-211
WAVETEK
SAN DIEGO
CALIFORNIA
SCHEMATIC -
CHASSIS
MODEL NO
133
DWG NO
D133 20C
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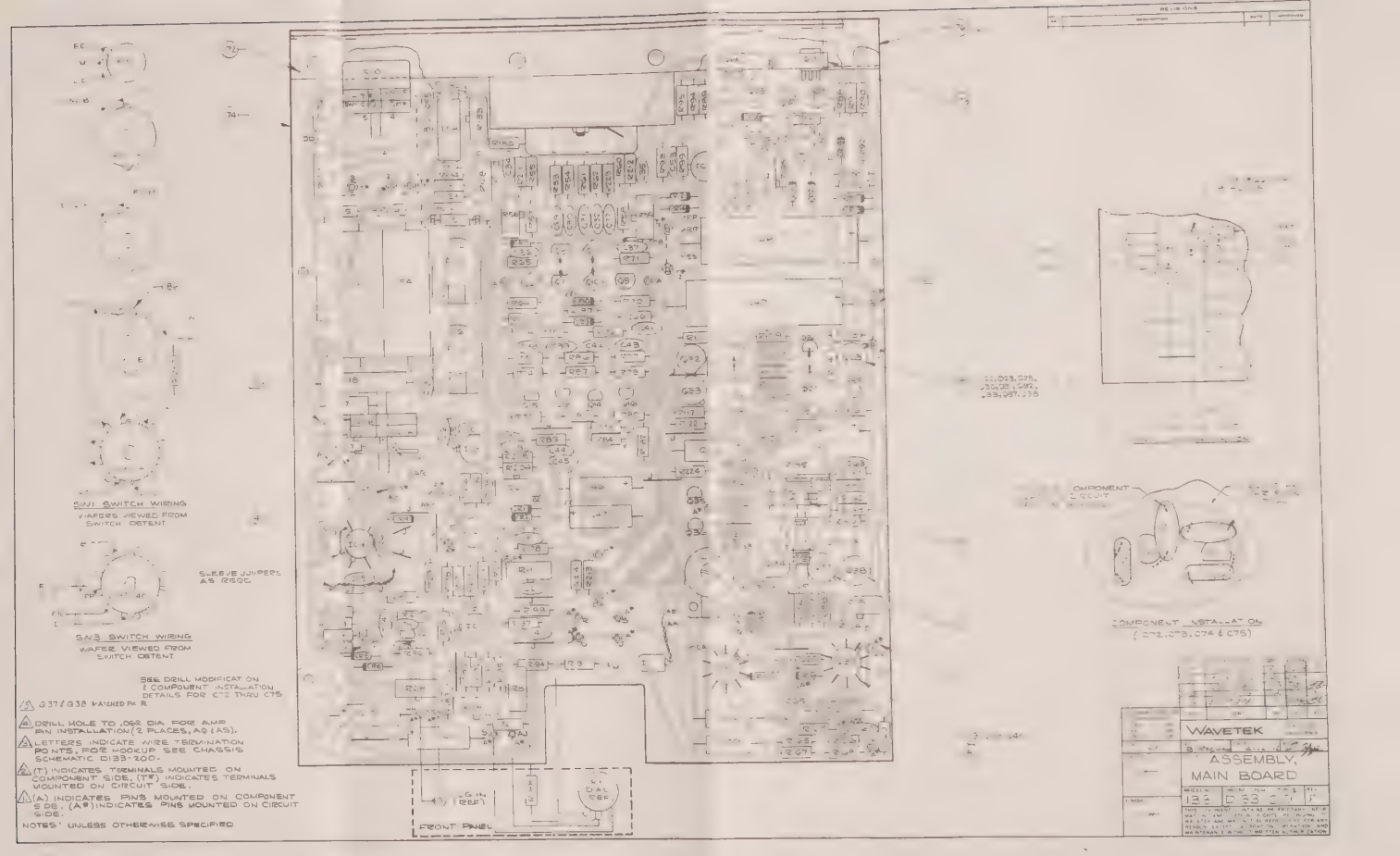
SW1 SWITCH WIRING
WAFERS VIEWED FROM SWITCH DETENT
SLEEVE JUMPERS AS REQ'D.
SW3 SWITCH WIRING
WAFER VIEWED FROM SWITCH DETENT
SEE DRILL MODIFICATION ON COMPONENT INSTALLATION DETAILS FOR C72 THRU C75
G37/G38 MATCHED PR.
DRILL HOLE TO .062 DIA FOR AMP PIN INSTALLATION (2 PLACES, AQ & AS).
LETTERS INDICATE WIRE TERMINATION POINTS. FOR HOOKUP SEE CHASSIS SCHEMATIC D133-200.
(T) INDICATES TERMINALS MOUNTED ON COMPONENT SIDE, (TF) INDICATES TERMINALS MOUNTED ON CIRCUIT SIDE.
(A) INDICATES PINS MOUNTED ON COMPONENT SIDE, (A*) INDICATES PINS MOUNTED ON CIRCUIT SIDE.
NOTES: UNLESS OTHERWISE SPECIFIED
FRONT PANEL
COMPONENT INSTALLATION
(C72, C73, C74 & C75)
WAVETEK
ASSEMBLY, MAIN BOARD
133 D 33

RESISTOR INSTALLATION
(R228 THRU R232)

SEE SHT 1

REV	DESCRIPTION	DATE	APPROVED
A	ECN # 438	JW	2/96

WAVETEK

ASSEMBLY,
M.A.M. BOARD

MODEL NO. 133 | DWG NO. D 33 010 | SHT 2 OF 4 | REV A

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PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N
1	CAPACITORS			
3	CERAMIC DISC 1000V 10% 22PF	CRL	71590	DD 220
4	CERAMIC DISC 1000V 10% 33PF	CRL	71590	DD 330
5	CERAMIC DISC 1000V 10% 47PF	CRL	71590	DD 470
6	SILVA MICA 500V 5% 68PF	ARCO	03797	DM15-680J
7	CERAMIC DISC 1000V 10% 150PF	CRL	71590	DD 151
8	CERAMIC DISC 1000V 5% 220PF	CRL	71590	DD 221
9	SILVA MICA 500V 5% 300PF	ARCO	03797	DM15 301J
10	CERAMIC DISC 1000V 1% 330PF	CRL	71590	DD 331F
11	SILVER MICA 500V 5% 560PF	ARCO	03797	DM15 561J
12	CERAMIC DISC 1000V 10% 680PF	CRL	71590	DD 681
13	SILVER MICA 500V 1% 910PF	ARCO	03797	DM15-911F
14	CERAMIC DISC 50V 10% 005uF	CRL	71590	UK 502
15	CERAMIC DISC 50V 10% .01uF	CRL	71590	UK 103
16	CERAMIC DISC 20V 10% .1uF	CR	71590	UK20 104
17	ELECTROLYTIC 15V 100uF	SPRAGUE	56289	1500107-016DC2
18	ELECTROLYTIC 35V 1000uF	SPRAGUE	56289	TE1030B035C4
19	VARIABLE 4.5-25PF	ERIE	72982	538-001-5T4
20	MATCHED CAPACITOR SET (5)	WAVETEK	29318	4196-504
21	.01uF	WAVETEK	29318	4196-504
22	.1uF	WAVETEK	29318	4196-504
23	.1uF	WAVETEK	29318	4196-504
24	.1uF	WAVETEK	29318	4196-504
25	.1uF	WAVETEK	29318	4196-504
26				
27				
28				
29				
30				
31	DIODES			
32	FD666	FAIRCHILD	27014	FD666
33	SCE	SEMTECH	24355	SCE-1
34	1N914	WAVETEK	29318	150-104
35				
36				
37				
38	INTEGRATED CIRCUITS			
39	(-13)uA709C	FAIRCHILD	27014	uA709C
40	(-16)CA3050	RCA	02214	CA3050
41	(-18)CA3035	RCA	02214	CA3035
42	LM101AH	NATIONAL	27014	LM101AH
43	(-14)uA709	FAIRCHILD	27014	uA709HC
44				
45				
46	POTENTIOMETERS			
47	200Ω	CRL	71590	BA1601 201
48	500Ω	CRL	71590	BA1601 502
49	500Ω	CRL	71590	BA1601 502
50	1K	CRL	71590	BA1601 801

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N
1		WAVETEK	29318	A130 R1A
2		TRL	71590	BA1603 B19
3				
4				
5				
6				
7	RESISTORS			
8	CARBON 1/2W 5% 4.7Ω	STACKPOLE	29504	RC20GF4R7J
9	CARBON 1/2W 5% 8.2Ω	STACKPOLE	29504	RC20GF8R2J
10	CARBON 1/2W 5% 10Ω	STACKPOLE	29504	RC20GF100J
11	CARBON 1/2W 5% 33Ω	STACKPOLE	29504	RC20GF330J
12	CARBON 1/2W 5% 47Ω	STACKPOLE	29504	RC20GF470J
13	CARBON 2W 10% 47Ω	STACKPOLE	29504	RC42GF470K
14	CARBON 1/2W 5% 56Ω	STACKPOLE	29504	RC20GF560J
15	CARBON 1/2W 5% 100Ω	STACKPOLE	29504	RC20GF101J
16	CARBON 1/2W 5% 220Ω	STACKPOLE	29504	RC20GF221J
17	CARBON 1/2W 10% 330Ω	STACKPOLE	29504	RC20GF331K
18	CARBON 1/2W 10% 470Ω	STACKPOLE	29504	RC20GF471K
19	CARBON 1/2W 10% 560Ω	STACKPOLE	29504	RC20GF561K
20	CARBON 1/2W 10% 680Ω	STACKPOLE	29504	RC20GF681K
21	CARBON 1/2W 5% 750Ω	STACKPOLE	29504	RC20GF751J
22	CARBON 1/2W 10% 1K	STACKPOLE	29504	RC20GF102K
23	CARBON 1 2W 10% 1.5K	STACKPOLE	29504	RC30GF152K
24	CARBON 1/2W 10% 2.2K	STACKPOLE	29504	RC20GF222K
25	CARBON 1 2W 10% 2.7K	STACKPOLE	29504	RC30GF272K
26	CARBON 1 2W 10% 5.6K	STACKPOLE	29504	RC20GF562K
27	CARBON 1 2W 10% 4.7K	STACKPOLE	29504	RC20GF472K
28	CARBON 1/2W 5% 6.2K	STACKPOLE	29504	RC20GF622J
29	CARBON 1/2W 5% 9.1K	STACKPOLE	29504	RC20GF912J
30	CARBON 1/2W 10% 10K	STACKPOLE	29504	RC20GF103K
31	CARBON 1/2W 5% 12K	STACKPOLE	29504	RC20GF123J
32	CARBON 1/2W 10% 18K	STACKPOLE	29504	RC20GF183K
33	CARBON 1/2W 10% 27K	STACKPOLE	29504	RC20GF273K
34	CARBON 1/2W 10% 220K	STACKPOLE	29504	RC20GF224K
35	CARBON 1/2W 10% 560K	STACKPOLE	29504	RC20GF564K
36	CARBON 1/2W 5% 680K	STACKPOLE	29504	RC20GF684J
37	CARBON 1/2W 10% 820K	STACKPOLE	29504	RC20GF824K
38	MST FILM 1/4W 1% 1M	CORNING	16299	RN60D1004F
39	CARBON 1/2W 5% 1.8M	STACKPOLE	29504	RC20GF185J
40	CARBON 1/2W 5% 2.2M	STACKPOLE	29504	RC20GF225J
41	CARBON 1/2W 5% 2.7M	STACKPOLE	29504	RC20GF275J
42	CARBON 1/2W 5% 4.7M	STACKPOLE	29504	RC20GF475J
43	CARBON 1/2W 5% 10M	STACKPOLE	29504	RC20GF106J
44				
45				
46				
47	METAL FILM 1 4W 1% 82.5Ω	CORNING	16299	RN60D8252F
48	METAL FILM 1/4W 1% 100Ω	CORNING	16299	RN60D1000F
49	METAL FILM 1/4W 1% 21.5Ω	CORNING	16299	RN60D21R5F
100	METAL FILM 1/4W 1% 47.2Ω	CORNING	16299	RN60D47R2F

LINE ITEM REFERENCE LIST

LINE NO.	REF DES	P/L NO.	REF DES	P/L NO.	REF DES	P/L NO.
1	C1	1	CR1	2	R1	1
2	C2	1	CR2	2	R2	1
3	C3	1	CR3	2	R3	1
4	C4	1	CR4	2	R4	1
5	C5	1	CR5	2	R5	1
6	C6	1	CR6	2	R6	1
7	C7	1	CR7	2	R7	1
8	C8	1	CR8	2	R8	1
9	C9	1	CR9	2	R9	1
10	C10	1	CR10	2	R10	1
11	C11	1	CR11	2	R11	1
12	C12	1	CR12	2	R12	1
13	C13	1	CR13	2	R13	1
14	C14	1	CR14	2	R14	1
15	C15	1	CR15	2	R15	1
16	C16	1	CR16	2	R16	1
17	C17	1	CR17	2	R17	1
18	C18	1	CR18	2	R18	1
19	C19	1	CR19	2	R19	1
20	C20	1	CR20	2	R20	1
21	C21	1	CR21	2	R21	1
22	C22	1	CR22	2	R22	1
23	C23	1	CR23	2	R23	1
24	C24	1	CR24	2	R24	1
25	C25	1	CR25	2	R25	1
26	C26	1	CR26	2	R26	1
27	C27	1	CR27	2	R27	1
28	C28	1	CR28	2	R28	1
29	C29	1	CR29	2	R29	1
30	C30	1	CR30	2	R30	1
31	C31	1	CR31	2	R31	1
32	C32	1	CR32	2	R32	1
33	C33	1	CR33	2	R33	1
34	C34	1	CR34	2	R34	1
35	C35	1	CR35	2	R35	1
36	C36	1	CR36	2	R36	1
37	C37	1	CR37	2	R37	1
38	C38	1	CR38	2	R38	1
39	C39	1	CR39	2	R39	1
40	C40	1	CR40	2	R40	1
41	C41	1	CR41	2	R41	1
42	C42	1	CR42	2	R42	1
43	C43	1	CR43	2	R43	1
44	C44	1	CR44	2	R44	1
45	C45	1	CR45	2	R45	1
46	C46	1	CR46	2	R46	1
47	C47	1	CR47	2	R47	1
48	C48	1	CR48	2	R48	1
49	C49	1	CR49	2	R49	1
50	C50	1	CR50	2	R50	1

SEE SHT 1

B			
A			
REV		DATE	BY

XX ±	0.0	WAVETEK	SAN DIEGO, CALIFORNIA
XX ±	0.00		
ANG ±	0.30		
SCALE	—	DRAWN	
MATERIAL		TITLE ASSEMBLY, MAIN BOARD	
#		MODEL NO. 33	DWG NO. 5 of 3 0F 4 5233-01C
FINISH			REV. -

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PARTS LIST

LINE NO	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
101	METAL FILM 1/4W 1% 46 ΩΩ	CORNING	16299	RN55D46R4F	2
102	METAL FILM 1/4W 1% 49 9Ω	CORNING	16299	RN55D49R9F	1
103	METAL FILM 1/4W 1% 68.1Ω	CORNING	16299	RN55D68R1F	1
104	METAL FILM 1/4W 1% 90 9Ω	CORNING	16299	RN55D90R9F	1
105	METAL FILM 1/4W 1% 1Ω00	CORNING	16299	RN60D1R00F	1
106	METAL FILM 1/4W 1% 1Ω00	CORNING	16299	RN60D1R00F	1
107	METAL FILM 1/4W 1% 2Ω90	CORNING	16299	RN60D2R90F	1
108	METAL FILM 1/4W 1% 3Ω62	CORNING	16299	RN60D3R60F	1
109	METAL FILM 1/4W 1% 3Ω20	CORNING	16299	RN60D3R20F	1
110	METAL FILM 1/4W 1% 9Ω90	CORNING	16299	RN60D9R90F	1
111	METAL FILM 1W 1% 681Ω	IRC	07716	MEC RM700B681F	1
112	METAL FILM 1/4W 1% 909Ω	CORNING	16299	RN60D909QF	1
113	METAL FILM 1/4W 1% 1K	CORNING	16299	RN60D 001F	1
114	METAL FILM 1/4W 1% 1.78K	CORNING	16299	RN60D1781F	1
115	METAL FILM 1/4W 1% 2.37K	CORNING	16299	RND02371F	1
116	METAL FILM 1/4W 1% 2 49K (-1)	CORNING	16299	RN60D2491F	1
117	METAL FILM 1/4W 1% 2 87K	CORNING	16299	RN60D2871F	1
118	METAL FILM 1/4W 1% 3 01K	CORNING	16299	RN60D3011F	1
119	METAL FILM 1/4W 1% 3 83K	CORNING	16299	RN60D3831F	1
120	METAL FILM 1/4W 1% 4 02K (-2)	CORNING	16299	RN60D4021F	1
121	METAL FILM 1/4W 1% 4 75K	CORNING	16299	RN60D4751F	1
122	METAL FILM 1/4W 1% 4 99K	CORNING	16299	RN60D4991F	1
123	METAL FILM 1/4W 1% 5 19K	CORNING	6299	RN60D5191F	1
124	METAL FILM 1/4W 1% 8.25K	CORNING	16299	RN60D8251F	1
125	METAL FILM 1/4W 1% 8 87K	CORNING	16299	RN60D8871F	1
126	METAL FILM 1/4W 1% 10K (-4)	CORNING	16299	RN60D1002F	4
127	METAL FILM 1/4W 1% 16 5K	CORNING	16299	RN60D1652F	1
128	METAL FILM 1/4W 1% 18 2K (-70)	CORNING	16299	RN60D1822F	1 (SEE NOTE)
129	METAL FILM 1/4W 1% 21 5K	CORNING	16299	RN60D2152F	1
130	METAL FILM 1/4W 1% 48 7K	CORNING	16299	RN60D4872F	1
131	METAL FILM 1/4W 1% 1M	CORNING	16299	RN60D1004F	6
132					
133					
134					
135					
136					
137					
138					
139					
140	TRANSISTORS				
141	2N2219A	FAIRCHILD	27888	2N2219A	1
142	2N2369	FAIRCHILD	27888	2N2369	2
143	2N2905	FAIRCHILD	27888	2N2905A	1
144	2N2905 (-83)	FAIRCHILD	27888	2N2905A	2
145	2N2905A	FAIRCHILD	27888	2N2905A	1
146	2N3799	FAIRCHILD	27888	2N3799	1
147	2N3638	FAIRCHILD	27888	2N3638	3
148	2N3638 (-93)	FAIRCHILD	27888	2N3638	2
149	2N3640	FAIRCHILD	27888	2N3640	1
150	2N3640 (-103)	FAIRCHILD	27888	2N3640	2

PARTS LIST

LINE NO	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
151	2N1646	FAIRCHILD	27871	2N5646	6
152	2N5646(-33)	FAIRCHILD	27871	2N1646	4
153	2N3903	MOTOROLA	[illegible]	2N3903	3
154	2N3905	MOTOROLA	[illegible]	2B3905	3
155	MODIFY PER 130-316	"	"	TIP29	3
156	MODIFY PER 130-316	"	"	TIP30	3
157	TD101	SPRAGUE	[illegible]	TD101	1
158	LOB	FAIRCHILD	27871	LOB	1
159					
160					
161					
162					
163	WAFER	WAVETEK	23338	B130-401	1
164	WAFER	WAVETEK	23338	A130 SW1-3	3
165	WAFER	CTS	21260	T106	1
166	WAFER	WAVETEK	23338	A133-SW1	1
167	DETENT	WAVETEK	23338	A130-SW1	1
168	SWITCH	WAVETEK	23338	B130-400	1
169					
170					
171	SINE MODULE	WAVETEK	23338	B130-311	1
172	BRACKET ASSY	WAVETEK	23338	0131 004	1
173	HEAT SINK	WAVETEK	23338	A130-311	1
174	CIRCUIT BOARD	WAVETEK	23338	130-1100	1
175	SUPPORT BLOCK	WAVETEK	23338	B130-328	1
176	MOUNTING BLOCK	WAVETEK	23338	A130-305	2
177					
178					
179	TRANSISTOR HEATSINK	WAKEFIELD	0587	NF 207	2
180	TRANSIPAD	M BOSS	07047	10123N	3
181	TRANSIPAD	M BOSS	07047	10150	2
182	LAMP	MURA	42555	L28/NO	1
83	TERMINAL (TURRET)	USECO	88247	70108	4
84	TERMINAL (BIFRUCATED)	USECO	88247	70008	6
185	AMP PIN	AMP	00779	61182-2	24
186	SOLDER LUG	[illegible]	83501	[illegible]	1

LINE ITEM REFERENCE LIST

REF DES	P/L NO	REF DES	P/L NO	REF DES	P/L NO
[illegible]	[illegible]	[illegible]	[illegible]	SW1	A-1F
[illegible]	[illegible]	[illegible]	[illegible]	SW1	B-1F
		[illegible]	[illegible]	SW2	C-1F
		[illegible]	[illegible]	SW2	D-1F
		[illegible]	[illegible]		
		[illegible]	[illegible]		
		[illegible]	[illegible]	SW1	1F
		[illegible]	[illegible]	SW1	2F
		[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	A1	[illegible]
		[illegible]	[illegible]	A1	1F
		[illegible]	[illegible]	A	1F
		[illegible]	[illegible]	T1	1F
		[illegible]	[illegible]	*2	2F

SEE SHT 1

REV	ECN	BY	DATE	APP
A	ECN 5333	JH	10/14/76	[illegible]
A	ECN 5470	JH	12-2-76	[illegible]

TOLERANCE UNLESS OTHERWISE SPEC: XXX .010, XX .030, ANGLES ± 0.3°

WAVETEK SAN DIEGO CALIFORNIA

SCALE —

BY: [illegible] DATE: 6-17-76 APP: [illegible]

MATERIAL —

TITLE: ASSEMBLY, MAIN BOARD

FINISH —

MODEL NO: 33 DWG NO: 0132-0101 SHT 4 OF 4 REV F

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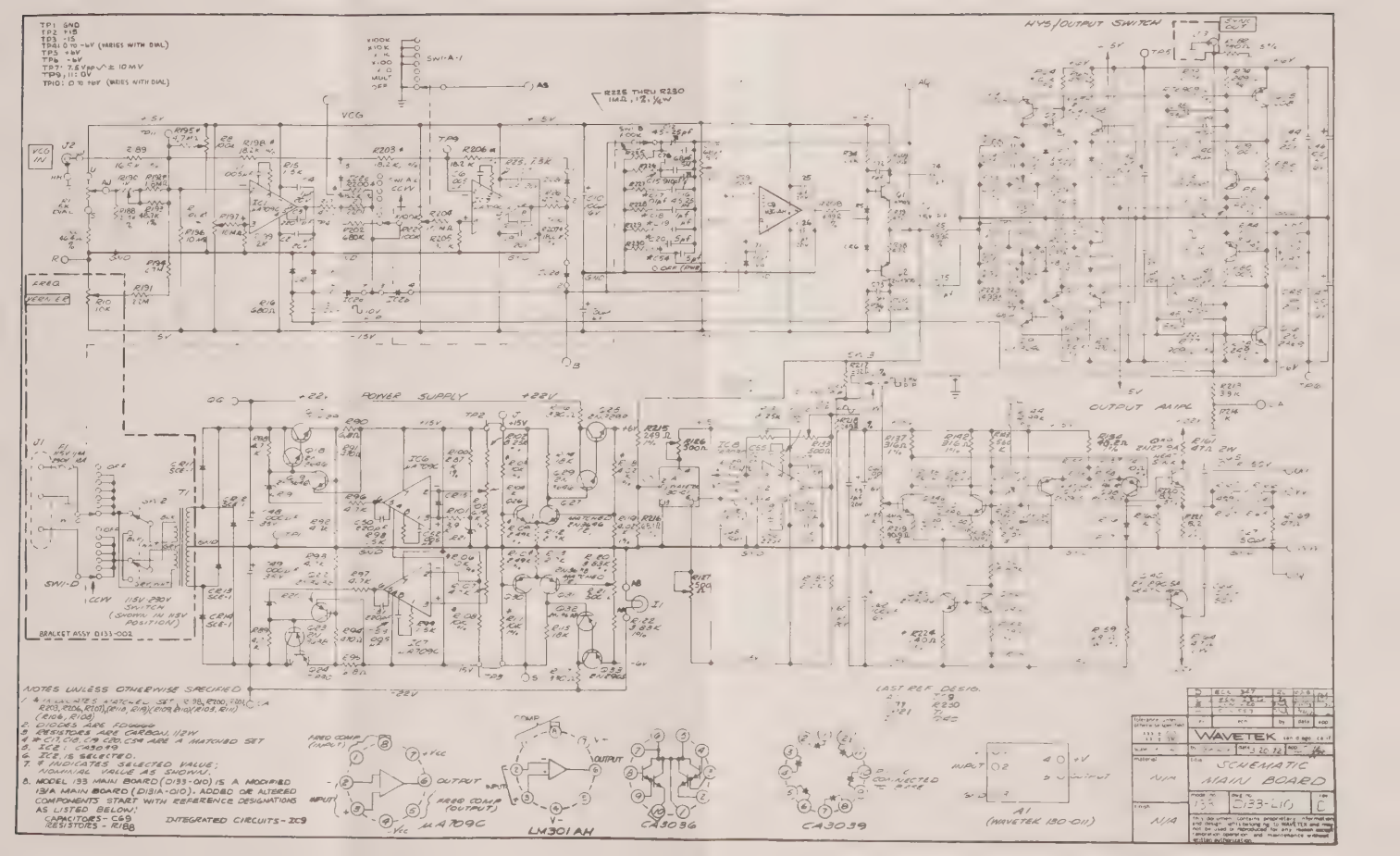
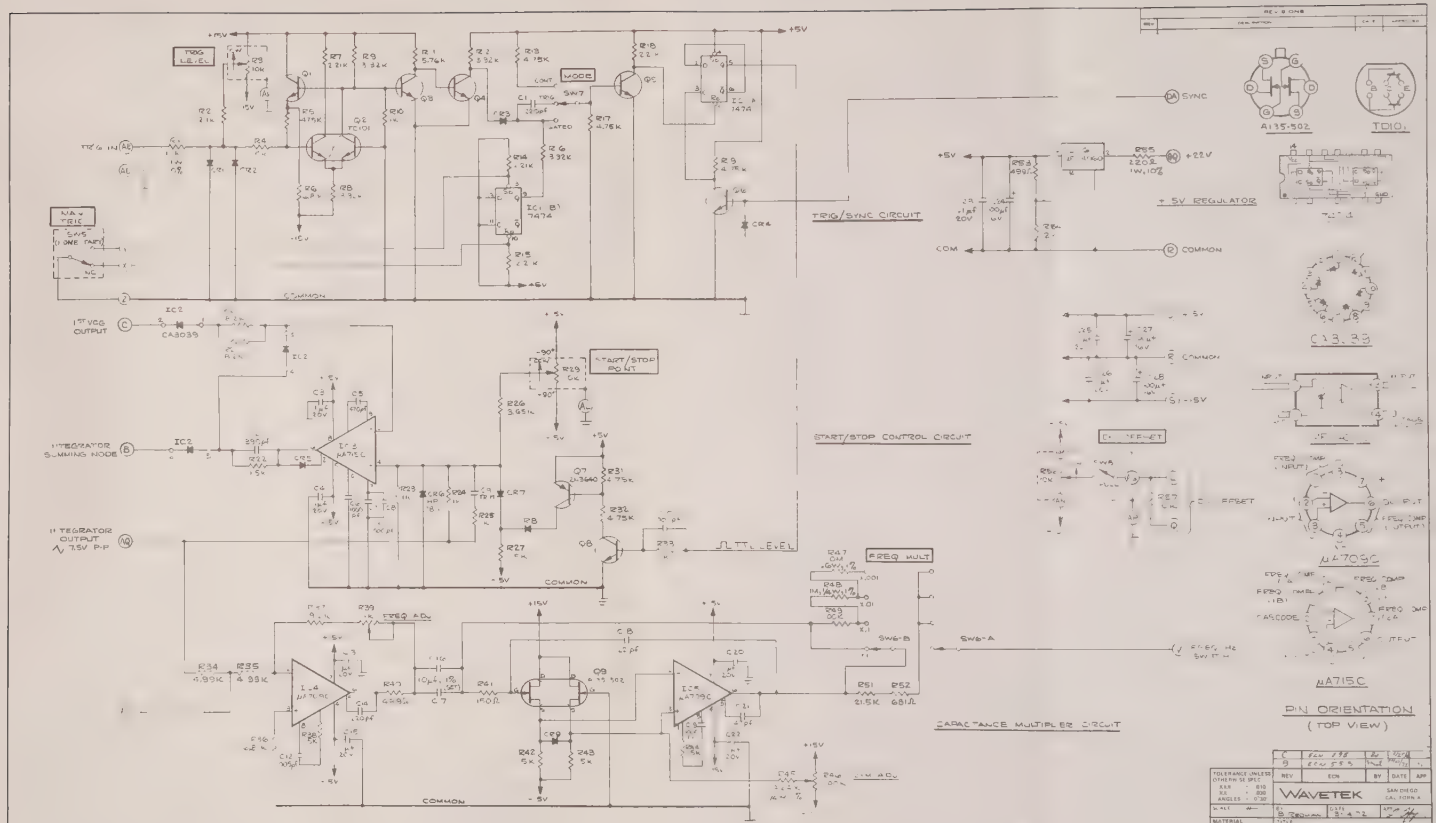
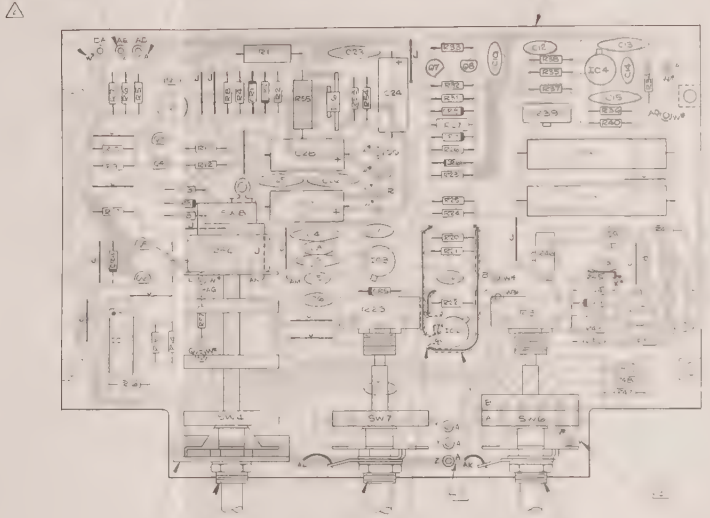

TP1: GND
TP2: +15
TP3: -15
TP4: 0 TO -4V (VARIES WITH DIAL)
TP5: +8V
TP6: -4V
TP7: 7.6 Vpp ∿ ± 10 MV
TP9: 11.5 DV
TP10: 0 TO 10V (VARIES WITH DIAL)
NYS/OUTPUT SWITCH
POWER SUPPLY
OUTPUT AMPL
SW1-A-1
SW1-B
SW1-D
115V-230V SWITCH (SHOWN IN 115V POSITION)
BRACKET ASSY D133-002
VCO IN
VCG
LOG
VERN EA
+5V
-5V
+15V
-15V
+22V
-22V
GND
NOTES UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS MATCHED SET R98, R100, R101, R103, R106, R107 (OPEN D133-010) R103, R110 (R103, R111)
2. DIODES ARE 1N914
3. RESISTORS ARE CARBON, 1/2W
4. * C17, C18, C19, C20, C54 ARE A MATCHED SET
5. IC2 = CA3049
6. IC2, 15 SELECTED.
7. # INDICATES SELECTED VALUE; NOMINAL VALUE AS SHOWN.
8. MODEL 133 MAIN BOARD (D133-010) IS A MODIFIED 131A MAIN BOARD (D131A-010). ADDED OR ALTERED COMPONENTS START WITH REFERENCE DESIGNATIONS AS LISTED BELOW:
CAPACITORS - C69
RESISTORS - R188
INTEGRATED CIRCUITS - IC9
HARD COMP (INPUT)
HARD COMP (OUTPUT)
OUTPUT
INPUT
+Vcc
-Vcc
μA709C
LM301AH
CA3096
CA3059
CONNECTED INTERNALLY
A1 (WAVETEK 130-011)
LAST REF. DESIG.
C121
R250
IC9
WAVETEK
SCHEMATIC
MAIN BOARD
D133-L(1)
C
N/A
N/A
PROPRIETARY INFORMATION


TRIG/SYNC CIRCUIT
+5V REGULATOR
START/STOP CONTROL CIRCUIT
CAPACITANCE MULTIPLER CIRCUIT
SYNC
COMMON
MODE
FREQ MULT
FREQ ADJ.
SLOPE
SYM ADJ.
TRIG IN
INTEGRATOR SUMMING NODE
INTEGRATOR OUTPUT
1ST VCG OUTPUT
CA3039
μA709C
μA715C
PIN ORIENTATION
(TOP VIEW)
A135-502
TO1O1
C13, 39
SCHEMATIC,
TRIG/MULT BOARD
WAVETEK
SAN DIEGO
CALIFORNIA
DRG NO 133-211
REV C
LAST REF DES USED
C28, CR9, IC6, R57, Q9, SW8
REF DES NOT USED
R28, R30, SW1, SW2, SW3, SW4, R50, C11
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL DIODES ARE FDG666.
2. ALL TRANSISTORS ARE 2N3646.
3. ALL RESISTORS ARE 1%, 1/8W METAL FILM.


SW4
SW7
SW6
IC4
IC5
C13
C24
R55
R56
R57
R58
R59
R60
R239
R240
R241
R242
R243
R244
R245
R246
R247
R248
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R268
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R270
R271
R272
R273
R274
R275
R276
R277
R278

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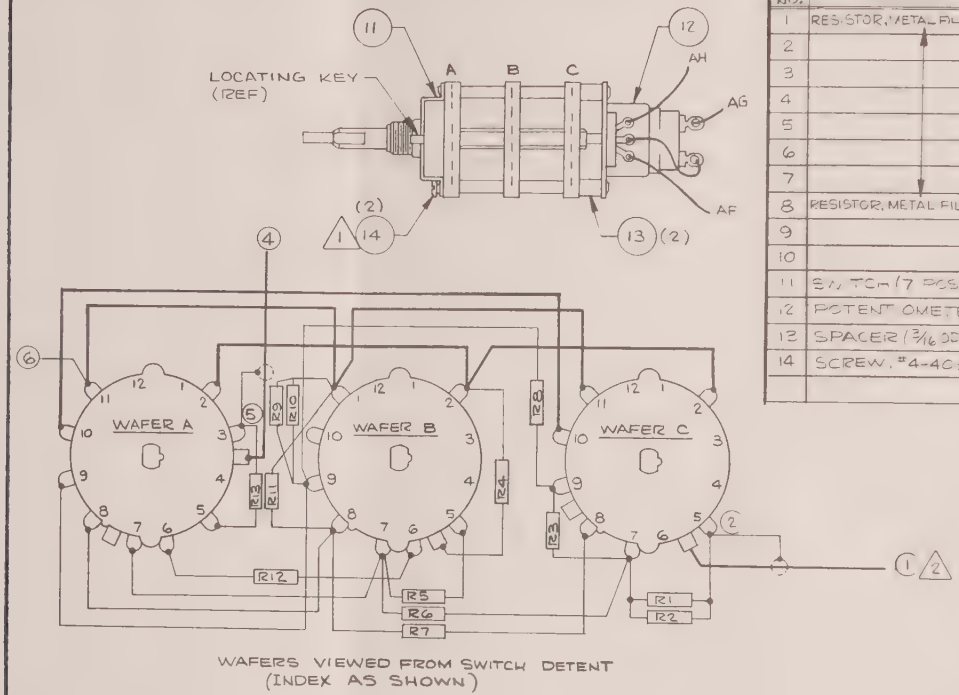
PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	CAPACITORS				
2	CERAMIC DISC, .0008V, 10%, 33PF	CRL	71590	DD-330	1
3	CERAMIC DISC, .0008V, 10%, 47PF	CRL	71590	DD 470	
4	CERAMIC DISC, .0008V, 10%, 100PF	CRL	71590	DD-101	1
5	CERAMIC DISC, .0008V, 10%, 220PF	CRL	71590	DD-221	2
6	CERAMIC DISC, .0008V, 10%, 390PF	CRL	71590	DD-391	1
7	CERAMIC DISC, .0008V, 10%, 470PF	CRL	71590	DD-471	
8	CERAMIC DISC, .0008V, 10%, 1000PF	CRL	71590	DD 102	1
9	CERAMIC DISC, 50V, 10%, 5600PF	CRL	71590	CK 562	
10	CERAMIC DISC, 20V, 10%, .1UF	CRL	71590	UK30-104	3
11	ELECTROLYTIC, 16V, 10%, 100UF	SPRAGUE	56289	500D107G016GC2	1
12	MATCHED CAPACITOR SET	WAVETEK	23338	B144-505	1
13					
14					
15					
16					
17	DIODES				
18	FD666	FAIRCHILD	27888	FD666	8
19	HP2811	HEWLETT PACKARD	28480		
20					
21					
22					
23					
24	INTEGRATED CIRCUITS				
25	SN7474	MOTOROLA	04713	SN7474	1
26	CA3039	RCA	86684	CA3039	1
27	μA715C	FAIRCHILD	27888	μA715C	1
28	E-133 μA709C	FAIRCHILD	27888	μA709C	2
29	MFC4060	MOTOROLA	04713	MFC4060	
30					
31					
32					
33					
34	POTENTIOMETER				
35	10K	WAVETEK	23338	133-0138	2
36	1K	CRL	71590	RA1603-802	
37	100K	CRL	71590	RA1603-803	
38					
39					
40					
41					
42					
43	RESISTORS				
44	CARBON 1W 10% 270Ω	STACKPOLE	24546	RC32GF271K	
45	METAL FILM 1/8W 1% 1K	CORNING	16299	RN55C	1
46	CARBON 1W 10% 10K	STACKPOLE	24546	RC32GF103K	1
47					
48					
49					
50	METAL FILM 1/8W 1% 49.9Ω	CORNING	16299		1
51	METAL FILM 1/8W 1% 1500	CORNING	16299	RN55D	1
52	METAL FILM 1/8W 1% 499Ω	CORNING	16299	RN55D	1

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
4F	METAL FILM 1/8W 1% 2K	CORNING	16299	RN55C	1
4F	METAL FILM 1/8W 1% 2.32K	CORNING	16299	RN55D	4
	METAL FILM 1/8W 1% 3.32K	CORNING	16299	RN55D	4
5A	METAL FILM 1/8W 1% 4.65K	CORNING	16299	RN55D	1
	METAL FILM 1/8W 1% 475K	CORNING	16299	RN55D	5
6A	METAL FILM 1/8W 1% 6.98K	CORNING	16299	RN55D	2
	METAL FILM 1/8W 1% 7.15K	CORNING	16299	RN55D	1
6F	METAL FILM 1/8W 1% 8.25K	CORNING	16299	RN55D	2
6F	METAL FILM 1/8W 1% 10K	CORNING	16299	RN55D	1
6F	METAL FILM 1/8W 1% 11.3K	CORNING	16299	RN55D	2
6F	METAL FILM 1/8W 1% 12.1K	CORNING	16299	RN55D	2
6F	METAL FILM 1/8W 1% 13K	CORNING	16299	RN55C	2
6F	METAL FILM 1/8W 1% 18.2K	CORNING	16299	RN55D	2
6F	METAL FILM 1/8W 1% 19.6K	CORNING	16299	RN55D	1
6F	METAL FILM 1/8W 1% 21.5K	CORNING	16299	RN55D	1
7	METAL FILM 1/8W 1% 47.5K	CORNING	16299	RN55C	1
7F	METAL FILM 1/8W 100K	CORNING	16299	RN55C	1
	FILM 1/8W 1% 499K	CORNING	16299	RN55C	1
	1/8W 1% 1M	CORNING	16299	RN55C	1
	1/8W 1% 10M	TRW CINCH	09647	MIL181	1
8F	2N3646	FAIR M.D	27888	2N3646	6
8F	TO103	SPRAGUE	56289	TO103	1
8F	2N3640	FAIRCHILD	27888	2N3640	1
8F	2N3 [illegible]	[illegible]	27888	MPF502	1
8F	"EAR D" BOARD	WAVETEK	23338	133-0138	1
8F	SWITCH ASSY ARMEN	WAVETEK	23338	B133-003	1
9F	SW PCB ASSY FREQ MULT	WAVETEK	23338	C133-002	1
9F	SWITCH ASSY MODE	WAVETEK	23338	C133-001	1
10	BRACKET	WAVETEK	23338	B133-305	1
6F	AMP PIN	AMP	00779	61182-7	8
7F	METAL FILM 1/8W 1% 21K	CORNING	16299	19910	4

LINE TEN REFERENCE LIST



WAFERS VIEWED FROM SWITCH DETENT (INDEX AS SHOWN)

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	RESISTOR, METAL FILM, 1/4W, 1%, 274Ω	CORNING	16299	RN60D27R4F	1
2	549Ω			RN60D54R9F	1
3	59Ω			RN60D59R0F	2
4	619Ω			RN60D61R9F	1
5	715Ω			RN60D71R5F	1
6	196Ω			RN60D1960F	4
7	249Ω			RN60D2490F	1
8	RESISTOR, METAL FILM, 1/4W, 1%, 8250Ω	CORNING	16299	RN60D8250F	2
9					
10					
11	SWITCH (7 POSITION)	WAVETEK	23338	A136-SW1B	1
12	POTENTIOMETER	WAVETEK	23338	A133-500	1
13	SPACER (3/16 OD x 1/4 LONG)	SMITH	83330	8501	2
14	SCREW, #4-40 x 2 LONG				2

LINE ITEM REFERENCE LIST

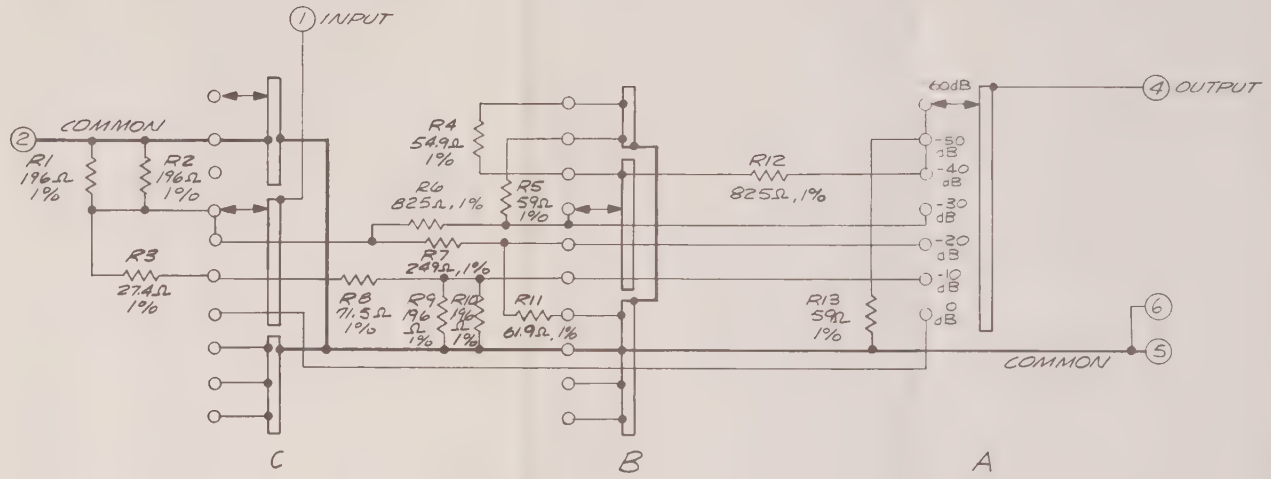
REF DES	P/L LINE	REF DES	P/L LINE
R1	6	R8	5
R2	6	R9	6
R3	1	R10	6
R4	2	R11	4
R5	3	R12	8
R6	8	R13	3
R7	7		

3. FOR ASSY SCHEMATIC SEE 0104-00-0406
2. FOR ASSY HOOKUP SEE CHASSIS SCHEMATIC D133-200.
1. REMOVE EXISTING SCREW, DRILL SCREW CLEARANCE HOLE THRU THREADED HOLE ON DETENT BRACKET & REPLACE WITH ITEM 14 (2 PLACES).

NOTES: UNLESS OTHERWISE SPECIFIED

A	ECN 903	BA	5-21-74		

N/A	B RICHAM 2-19-74	SWITCH ASSY. ATTEN	
N/A		133	B133-001 A
N/A			



NOTES: UNLESS OTHERWISE SPECIFIED

1. CIRCLED NUMBERS, I.E. (1) ETC, INDICATE WIRING INTERCONNECTIONS.

A	ECN 321	11/6	12/6		
REV	ECN	BY	DATE	APP	

WAVETEK SAN DIEGO, CA

DRAWN	B.	DATE 5-20	SIZE B
TITLE	SCHEMATIC, ATTENUATOR		
DWG NO	144 0104-00-0406		REV A

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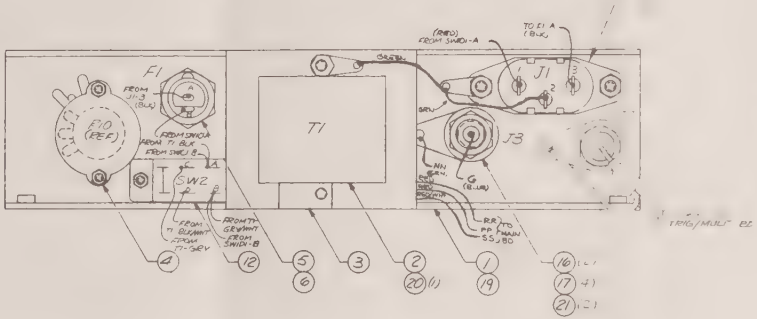


TRIG/MULTI PC

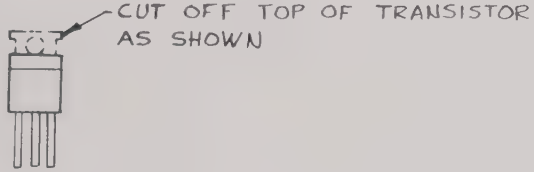
PARTS LIST

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY	
		BRACKET	WAVETEK	813-302	1	
2	T1	TRANSFORMER		6130 500	1	
3		TRANSFORMER BRACKET		4130 306	1	
4						
5	F1	RECEPTACLE, FUSE	LITTELFUSE	313 220	1	FOR 115V MODEL
6		FUSE HOLDER		342012	1	
7		1.6 AMP 250V			1	FOR 230V MODEL
8	J	POWER RECEPTACLE	SWITCHCRAFT	EAC3-6	1	
9						
10						
11	SW2	115 230V SWITCH	SWITCHCRAFT	8625LP (SUPERSEDED)	1	
12						
13						
14						
15		BNC CONNECTOR	KING	KC7946		
16		SHOULDER WASHER	SMITH	2668	2	
17						
18		FASTENERS 4-32	SOUTHCO	4 - 100 3	4	
19		SOLDER LUG	H H SMITH	1414-4	2	
20		SOLDER LUG		437		
21						
22		MICA INSULATOR	WAVETEK	4780 307	1	
23						
24						

E	ECN 847	RS	6-7-81		
A	ECN 838	BA	1-7-81		

WAVETEK

ASSY, BRACKET



tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale	by	date	app.		
material TIP 29 TIP 30	title TRANSISTOR MODIFICATION				
finish	model no. 130 SERIES	dwg no. A130-316			rev

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tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale	by	date	app.		
material TIP 29 TIP 30	title TRANSISTOR MODIFICATION				
finish	model no. 130 SERIES	dwg no. A130-316	rev		

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